SCIENCE ABSTRACTS.

Section A.—PHYSICS.

MARCH 1914.

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SCIENCE ABSTRACTS.

Section A.—PHYSICS.

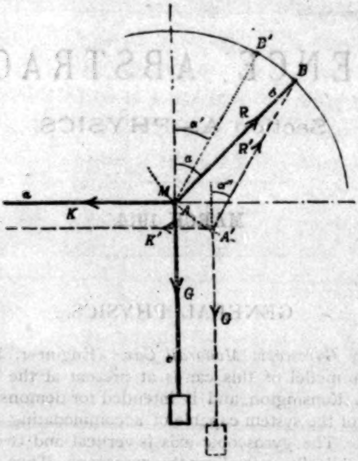
MARCH 1914.

GENERAL PHYSICS.

370. *Schilowsky Gyroscopic Monorail Car.* (Engineer, 117. pp. 106–107, Jan. 23, 1914.)—A model of this car is at present at the Imperial College of Science, South Kensington, and is intended for demonstration purposes. A larger example of the system capable of accommodating six passengers is nearly completed. The gyroscopic axis is vertical and two pendulums are provided for automatically controlling the gyroscope. Thus, if the car lurches to the right, the left-hand pendulum pulls a cord and so puts a rack and pinion into mesh. This, in turn, gives such an action on the gyroscope as to call forth for it the desired righting torque and so balance the car. E. H. B.

371. *Some Improvements in the Bimetallic Actinometer.* **W. Michelson.** (Meteorolog. Zeitschr. 30. pp. 577–580, Dec., 1913.)—The author describes certain improvements of detail in his bimetallic actinometer described in Abstract No. 1397 (1908). It had been found that while certain of the instruments in the hands of careful observers gave quite satisfactory and accurate results, other instruments appeared to be very variable in their indications. The improvements tend to render the actinometer less liable to misuse by an unpractised observer. The principle of the instrument is that the sun is allowed to shine through a movable cover upon a small bimetallic plate (11 × 1·7 × 0·05 mm.) of iron and invar. The increase of temperature communicated to the plate is shown by a bending of the plate, the amount of which is indicated by a light pointer of Al fixed to the plate and observed through a microscope provided with a suitable scale. The principal improvement consists in the reduction of the size of the plate to that given above, as it was found that the weight alone of the former plate was sufficient to produce an appreciable amount of bending when the instrument was directed towards parts of the sky which differed appreciably in altitude. The instrument now appears to give remarkably accurate results, and the scale value remains nearly invariable when tested by means of a standard Ångström pyrheliometer. R. C.

372. *Instrument for Measuring Forces.* **K. Schmiedel.** (Zeitschr. Instrumentenk. 33. pp. 373–375, Dec., 1913.)—Describes an instrument designed for measuring forces of from 0·2 gm. to 50 gm. weight, the principle of the parallelogram of forces being utilised. The three threads (cocoon fibres) *a*, *b*, and *c*, are fastened together at A. The force K to be measured is applied to *a*; a weight G is attached to *c*; the end B of the thread *b*, which takes the resulting reaction, can be moved along a circular scale. In correct adjustment the point A coincides with the centre M of the circular scale. If K and G are at right angles to one another, then K = G tan *a*. If K now varies to a value K′, and remains horizontal, the same weight G being used, the point A moves to a new position A′. B is then moved until A once more coincides with M. A photograph of the actual instrument is given, with particulars of the construction and method of adjustment. A. W.



373. *Densities of Dilute Aqueous Solutions by a New Method.* **A. B. Lamb and R. E. Lee.** (Amer. Chem. Soc., Journ. 35. pp. 1666–1698, Nov., 1913.)—In order to measure the relative densities of aqueous solutions to eight places of decimals a glass float was used, which could be loaded by Pt weights of 1 mgm. dropped into a hollow at the top of the float. The float was totally submerged in the liquid to be tested, and the final adjustment of buoyancy was made by the action of an electromagnetic field on a piece of soft iron enclosed in the float. In making an observation the float was drawn down until a Pt point at the bottom of the float occupied a central position in a cup at the bottom of the liquid; the current in the coils was then reduced until the point just escaped from contact, as observed by means of a microscope immersed in the solution. The weight of the bulb *in vacuo* was 234·5681 gm. It displaced 235·1089 cm.^{3} of water at 20·004° on the hydrogen scale. The electromagnetic effect was found to be 0·04772 ± 0·00014 mgm. per milliamp. and enabled readings of buoyancy to be taken to 0·02 mgm. or about 0·000 000 08 gm./cm.^{3} in the density. In comparing very dilute solutions with pure water it was only necessary to be sure that the temperatures were identical: by immersing everything in a big thermostat the temperature-variations were reduced to 0·001°, or ±0·0005°, equal to 0·00000009 in the density. The max. error from all sources was calculated to be 0·0000008, but in practice it was found to be about one-tenth of this, and under favourable conditions might be 5 or 10 times less.

By this method solution-volumes can be measured accurately for solutions from 0·01 to 0·0001 gm. equivalents per litre; even in the most dilute of these solutions the errors appeared in practice to be only about 0·1 %. T. M. L.

374. *Specific Gravity and Displacement of Saline Solutions.* **J. Y. Buchanan.** (Roy. Soc. Edinburgh, Trans. 49. No. 1. pp. 1–227, 1912–1913.)—A minute description is given of experiments on the density and displacement of saline solutions by means of accurate hydrometers. Data are given which show that in a series of observations two experimenters can obtain results differing on the average by about 0·000006, *i.e.* about the same degree of accuracy as that attained with Bousfield's larger pyknometers. In contrast with the American workers, Lamb and Lee [see preceding Abstract], who have succeeded in measuring the densities of dilute solutions to nine significant figures, the author uses a hydrometer with an exposed stem and works at room-temperature without using a thermostat of any kind. On the other hand, he has been able, by using an open in place of a closed hydrometer, to load the instrument with additional mercury and to extend the observations even to supersaturated solutions of calcium chloride; these solutions showed remarkable oscillations of density prior to crystallisation. The unsaturated solutions examined were chiefly chlorides, bromides, iodides, nitrates, chlorates, bromates, and iodates of potassium rubidium, and cæsium.

For data and results the original paper must be consulted. T. M. L.

375. *Determination of Mineral and Rock Densities at High Temperatures.* **A. L. Day, R. B. Sosman** and **J. C. Hostetter.** (Amer. Journ. Sci. 37. pp. 1–39, Jan., 1914.)—After reviewing existing and rather conflicting data on the change in volume on fusion of various rocks, the authors describe apparatus by which the volume of metals and of solid and liquid silicates can be determined from 250° to 1600°. The sensitiveness of the method is from 0·03 to 0·2 per cent. The accuracy varies with the metal used, the temperature, and the size of the sample, but is usually between 0·2 and 0·5 per cent. The fundamental constant is the expansion coefficient of artificial graphite. Volume measurements on quartz up to 1600° show a dilatation which increases rapidly as the inversion point of 575° is approached. Above this temperature quartz contracts slightly. At about 1300° there begins a second and irreversible dilatation due to the formation of cristobalite. Owing to the unequal expansion of the various minerals the rock is fractured, so that the true volume-change over any considerable range cannot be obtained from natural rocks. L. H. W.

376. *Change in Elasticity of a Copper Wire with Current and External Heating.* **H. L. Dodge.** (Phys. Rev. 2. Ser. 2. pp. 431–449, Dec., 1913.)—Describes experiments on the change of Young's modulus for a copper wire when heated (i) by an external source, and (ii) by the passage of an electric current through the wire. The object of the experiments was to discover if there was any difference in the changes produced by the two methods of heating. Preliminary work showed that there were no sudden changes in the elastic state of the wire, and that rapidity of heating or cooling, or the length of time for which a given temperature was maintained, had very slight effect. The method of experiment is described and modulus-temperature curves are drawn, embodying the results of a large number of determinations made over the range from 20° to 150° C. The wire was taken repeatedly backwards and forwards over the whole range, and the closeness with which the curve returns on itself shows the absence of any hysteresis or history effects. The curves for the same specimen of wire under the two methods of heating are practically identical, and it is hence concluded that the passage of a current along a copper wire has no other effect on Young's modulus than that due to the consequent change of temperature. The modulus, in both cases, decreases at a growing rate with rise of temperature. Experiments are in progress with iron and other metals. J. W. T. W.

377. *Tungsten Wire Suspensions for Magnetometers.* **S. Chapman** and **W. W. Bryant.** (Nature, 92. p. 585, Jan. 22, 1914.)—Tungsten wires of 20 microns diam., such as are used in metallic filament lamps, have been adopted instead of silk or quartz for suspending a declination magnet weighing 50 gm. The effect of 90° torsion was to turn the magnet through 4′. With this wire, the zero does not change within the limits of measurement, and the wire can be obtained at 3d. per foot. G. E. A.

378. *Determination of the True Stresses during Tensile Tests at any desired Temperature.* **F. Hauser.** (Deutsch. Phys. Gesell., Verh. 15. 24. pp. 1278–1300, Dec. 30, 1913.)—A photographic method of determining the change of section of a bar under tensile loads at various temperatures has been worked out. The test-piece and shackles are enclosed in a square box which can be heated up to 210° C. by means of a current of hot air from a side-chamber. Two adjacent sides of the box are illuminated, while photographs of the bar can be taken through windows in the other sides. Preliminary tests on solder (78·78 % Sn and 20·62 % Pb) showed that the method was quite reliable for recording simultaneous loads and changes of section in materials undergoing considerable deformation under stress. Tests made on pure zinc showed that at low temperatures the stress calculated on the original section differed very little from the true stress (calculated on the reduced area). Fracture commences as soon as the max. load is attained, and is propagated rapidly across the whole section, so that very little contraction occurs and the max. load and tensile strength are equal. At higher temperatures, however, the fracture takes place more slowly; the true stress attains its maximum some time before breakage occurs, resulting in a greater amount of deformation which increases with the temperature. Mean values show that pure zinc loses its strength slowly up to 60° C. and then more rapidly as the temperature rises. During the whole period the elongation gradually increases. There is no minimum strength and max. elongation at 150° C. such as would be expected from the behaviour of "rolling" zinc at this temperature. The difference in properties between pure and technical zinc in this respect is ascribed to the presence of impurities in the latter. Tin shows 100 % contraction at all temperatures, so that the true stresses had to be determined by continuing the stress-strain diagrams to 100 % contraction. These values, plotted in terms of the temperature, show that the strength of tin up to 210° C. decreases along a logarithmic curve showing a true stress of 300 kg./cm.^{2} at 0° C. The elongation rapidly attains a max. value at 60° C., after which it diminishes slowly with increasing temperature. F. C. A. H. L.

379. *Method for Measuring the Pressure produced in the Detonation of High Explosives or by the Impact of Bullets.* B. **Hopkinson.** (Roy. Soc., Phil. Trans. 213. pp. 437–456, Jan. 31, 1914.)—The determination of the actual pressures produced by a blow such as that of a rifle bullet or by the detonation of high explosives, is a problem of much scientific and practical interest but of considerable difficulty. It is easy to measure the transfer of momentum associated with the blow, which is equal to the average pressure developed multiplied by the time during which it acts, but the separation of these two factors has not hitherto been effected. The direct determination of a force acting for a few hundred-thousandths of a second presents difficulties which may perhaps be called insuperable, but the measurement of the other factor, the duration of the blow, is more feasible. In the case of impacts such as those of spheres or rods moving at moderate velocities, the time of contact can be determined electrically with considerable accuracy [see Abstract No. 1988 (1907)]. The present paper contains an account of a method of analysing experimentally more violent blows, and of measuring their duration and the pressures developed. The theoretical basis of the method receives elaborate exposition in the paper. If a rifle bullet be fired against the end of a cylindrical steel rod there is a definite pressure applied on the end of the rod at each instant of time during the period of impact, and the pressure can be plotted as a function of the time. The pressure-time curve is a perfectly definite thing, though the ordinates are expressed in tons and the abscissæ in millionths of a second. The result of applying this varying pressure to the end is to send along the rod a wave of pressure which, so long as the elasticity is perfect, travels without change of type. If the pressure in different sections of the rod be plotted at any instant, then at a later time the same curve shifted to the right by a distance proportional to the time will represent the then distribution of pressure. As the wave travels over any section of the rod, that section successively experiences pressures represented by the successive ordinates of the curve as they pass over it. The progress of the wave of stress along the rod is accompanied by corresponding strain and therefore by movement, the same curve which represents the distribution of pressure at any moment also representing the distribution of velocity in the rod. When the wave reaches the free end of the rod it is reflected as a wave of tension which comes back with the same velocity as the pressure-wave, and the state of stress in the rod subsequently is to be determined by adding the effects of the direct and of the reflected waves. The author takes the case of a rod divided at some section near the free end, the opposed surfaces of the cut being in firm contact and carefully faced. The wave of pressure travels over the joint practically unchanged, and pressure continues to act between the faces until the reflected tension wave arrives at the joint. The pressure is then reduced by the amount of the tension due to the reflected wave, and as soon as this overbalances at the section the pressure of the direct wave, the rod, being unable to withstand tension at the joint, parts there and the end flies off with a quantity of momentum which may be measured by a ballistic pendulum. By taking end-pieces of different lengths and measuring the momentum so trapped in each, the area of the pressure-time curve over corresponding intervals can be obtained. In general the precise form of the curve itself cannot be deduced because the points of commencement of the several intervals are not known, but the max. pressure and the total duration of the impact can always be obtained. The max. pressure is the limiting value of the average acting on a piece when the piece is very short, and the duration corresponds to twice that

length of piece which just catches the whole of the momentum, leaving the rod at rest. This is the basis of the method described in the present paper. A cylindrical rod or shaft of steel is hung up horizontally by four equal threads, so that it can swing in a vertical plane remaining parallel to itself. A short piece of rod of the same diam. is butted up against one end, being held on by magnetic attraction but otherwise free. A rifle bullet is fired at, or gun-cotton is detonated near the other end; the short piece flies off and is caught in a box suspended in a similar manner to the long rod. Suitable recording arrangements register the movement both of the long rod and of the box, and the momentum in each is calculated in the usual way as for a ballistic pendulum. Sufficient magnetic force to hold the end-piece in position is provided by putting a solenoid round the rod in the neighbourhood of the joint. The slight force required to separate the piece from the rod under these conditions may be neglected in comparison with the pressures and tensions set up, since these amount to several tons on the square inch; and practically speaking, the joint will transmit the pressure wave unchanged but will sustain no tension.

The pressure produced by the impact of lead bullets is first recorded, since this may be predicted theoretically and so serve as a check for the method. At velocities exceeding 1000 ft. per sec. lead behaves on impact against a hard surface practically as a perfect fluid. Most of the experiments were made with the service cartridge, in the service rifle, giving an average velocity of 2000 ft. per sec. Tables, curves, and discussion of results then follow. The effect of the rigidity of the bullet next receives attention. In the simple theory it is assumed that the bullet is absolutely fluid, but corrections have to be made owing in part to a certain rigidity due to the nickel casing, and in part to the viscosity of lead, the effect of which may be quite appreciable at such high speeds of deformation. A discussion is then given of errors inherent in the method of experiment. Experiments were also undertaken at lower velocities, and a table of results is given. The author finally deals with the detonation of gun-cotton, experiments being made with the method above described which, although only giving approximate results owing to the quite small charges used, yet throws light on a matter of which little is known. The author concludes that the most probable account of the smashing of a mild-steel plate is that the plate is cracked before it has appreciably deformed, the cracks being caused by relative velocity given impulsively to different parts of the plate. Bending of the broken pieces occurs after the plate has cracked and the pieces have separated from one another, and is due to relative velocity in different portions of each piece, which still persists after the initial fracture and is taken up as a permanent set in each piece. The author is of opinion that his experiments on gun-cotton pressures supply sufficient evidence that the blow may be regarded as an impulsive force communicating velocity instantaneously. Several tables, diagrams, and photographs illustrate this particular section. H. H. Ho.

380. *Effects of the Detonation of Gun-cotton.* **B. Hopkinson.** (Engineering, 97. pp. 199–201, Feb. 6, 1914. Paper read before the N.E. Coast Inst. of Engin. and Shipbuilders, Jan. 30, 1914. Roy. Soc., Proc. Ser. A. 89. pp. 411–413, Jan. 1, 1914. Abstract.)—The paper contains an account of experimental methods for measuring the pressure produced by the detonation of explosives [see also preceding Abstract]. At the outset the author gives an outline of the mechanism of explosion, referring to A. Noble's work on the pressure developed; the latter's work was limited to the less powerful explosives owing to the fact that no measuring apparatus was available which could withstand these pressures without damage. A short description of the practical effects produced by the pressure developed during the detonation of explosives is then given. When gun-cotton is detonated in the open without tamping of any kind, a highly-ductile mild steel under this particular type of stress behaves like a brittle body. There is usually some distortion of the broken pieces of the plate; but there is reason to suppose that this occurs after the fracture, and that the immediate effect of the blow is to shatter, as though it were cast-iron, a material which in a press can be bent double without showing a crack. The author claims this action to be well worthy of further study by all engineers, because of the light which such study may throw on the properties of the material with which they work. From this point of view the author approaches the subject for devising a means of analysing the blow given by the detonation of gun-cotton. Details of the method then follow for which see also the other paper referred to (*loc. cit.*). H. H. Ho.

381. *The Supposed Relation between Elasticity and the Heat of Fusion of Metals.* **F. Lejeune.** (Akad. Wiss. Wien, Ber. 122. 2a. pp. 739–749, April, 1913.)—The author shows that Guldberg's relation between the elasticity coefficient, E, the density, *d*, and the latent heat of fusion, λ, of metals, namely $E = 40d\lambda$, gives better results for the metals Pb, Zn, Ag, and Cu when the numerical coefficient is changed to 33; the relation does not hold for alloys, cast-iron, and Pt. For drawn wires, better results are obtained if, instead of the latent heat of fusion, the total heat of fusion (Q), reckoned from the temperature at which the elasticity modulus is determined, is taken; the relation $E = 10Q$ then gives good results. Theoretical considerations indicate that instead of an alteration in length, an alteration in volume should be taken into account, and the author finds in the case of 16 metals, including alloys, the relation $s^2/E^3 = \text{const.}$, gives good results, where *s* is specific tension at the elasticity limit. T. S. P.

382. *On the General Theory of Elastic Stability.* **R. V. Southwell.** (Roy. Soc., Phil. Trans. 213. pp. 187–244, Aug. 6, 1913.)—The paper is mainly mathematical and treats of the theory of the stability of boiler-flues and tubular struts; the experimental portion has already been dealt with [Abstract Nos. 7 and 1241 (1913)]. The treatment is given under the headings: Equations of neutral equilibrium in rectangular and in cylindrical co-ordinates. General theory of instability in materials of finite strength. L. H. W.

383. *The Measurement of Stresses in Materials and Structures.* **E. G. Coker.** (Soc. Arts, Journ. 62. pp. 123–133, Jan. 2; 144–153, Jan. 9, and pp. 162–172, Jan. 16, 1914. Mech. Eng. 33. pp. 83–86, Jan. 23; 107–110, Jan. 30; 130–133, Feb. 6, and pp. 150–153, Feb. 13, 1914.)—Deals with general methods, and then very fully with the application of the optical method of testing by means of double-refraction made evident by plane-polarised light [see Abstracts Nos. 776, 1627 (1912), and 320, 906 (1913)]. L. H. W.

384. ***Application of Graphical Methods to the Solution of Problems on Struts and Tie-rods with Lateral and Non-axial Loads.*** **C. H. Lander.** (Phil. Mag. 27. pp. 203–213, Jan., 1914.)

385. *Fourier Analysis.* **F. W. Grover.** (Bureau of Standards, Bull. 9. pp. 567–646, Dec. 15, 1913.)—By his method of grouping similar terms Runge has greatly simplified harmonic analysis. The object of this paper is

still further to lessen the labour of analysing curves and more especially to facilitate the analysis of alternating current waves. The arrangement of the calculation is given in detail for three special cases, namely, for 6, 12, and 18 measured ordinates per half-period. Useful equations are also given for checking the accuracy of the results obtained. Numerical examples are given which show clearly that when higher harmonics are present a considerable number of ordinates must be measured in order to secure accuracy. The value of harmonic analysis for computing average and effective values, average power, etc., is pointed out. In the Appendix several valuable schedules and tables for use in Fourier analysis are given. A. R.

386. *Stability of the Laminar Motion of an Inviscid Fluid.* **Rayleigh.** (Phil. Mag. 26. pp. 1001–1010, Dec., 1913.)—A mathematical treatment of the subject, with applications to (i) the case (considered by Orr) of a simple shearing motion between two walls with a composite disturbance, periodic with respect to x but not with respect to t; (ii) the disturbance due to a single vortex filament in which the vorticity differs from the otherwise uniform vorticity of the neighbouring fluid. A. W.

387. *The Flow of Air through Capillary Tubes.* **I. M. Rapp.** (Phys. Rev. 2. Ser. 2. pp. 363–382, Nov., 1913.)—Describes experimental determinations, by the capillary tube method, of the absolute coefficient of viscosity of air (η), every endeavour being made to eliminate all sources of possible error by (i) the selection of very uniform tubes and their thorough cleansing and accurate calibration; (ii) the use of a considerable number of tubes of different dimensions; (iii) the use of small, *constant*, and accurately measured driving pressures; and (iv) the experimental study of the end correction. The value of the radius (R) to be used for each tube in calculating from Poiseuille's formula was obtained from calibration by the method used by Fisher [Abstract No. 661 (1909)], while corrections were applied for the shape of the meniscus and for slip. Different values of η were obtained by using different driving pressures on the same tube or different tubes at the same driving pressure, these differences being due to the energy in the stream-lines at the ends of the tubes. Corrections for this effect were applied by Brillouin's and by Fisher's methods, both formulæ giving good agreement within the assigned limits of experimental error. Special experiments with three different lengths of a wider tube, however, gave a superiority for Fisher's formula. In the final deduction of the value of η use was made only of those values given by tubes in which the end correction was small, and the mean of the corrected values obtained by both formulæ was taken as the true value. This is given as 1837·5 (10^7) gm./cm. sec. for dry air at 29° C., with an estimated error of 0·1 %. This value agrees with most determinations made by other methods. J. W. T. W.

388. *Hydrodynamical Actions of Vibrating Air on Two Spheres.* **G. Thomas.** (Ann. d. Physik, 42. 6. pp. 1079–1098, Dec. 23, 1913. From Dissertation, Giessen).—The aerial oscillations are produced by a cylinder mounted on one prong of an electrically maintained tuning-fork of frequency 81 per sec. The spheres under examination are within the vibrating cylinder, and the forces between are measured by a torsion balance, their distance and motion being observed microscopically. The experiments show that the forces have always the directions that the

theory gives for non-viscous fluids. For distances apart less than the radius of the spheres, however, the equatorial repulsions and axial attractions were never observed. E. H. B.

389. *Viscosity of the Atom.* **L. Décombe.** (Journ. de Physique, 3. Ser. 5. pp. 869–881, Nov., 1913.)—The general theory previously developed is here applied to the viscosity of the atom which is assimilated to an assemblage of little dynamical systems, each formed of a certain number of electrons describing the same orbit under the action of a central force proportional to the distance. [See Abstracts Nos. 1015 and 1393 (1913).] E. H. B.

390. *Relativity Dynamics of Homogeneous Bodies.* **K. Schaposchnikow.** (Ann. d. Physik, 42. 6. pp. 1572–1574, Dec. 23, 1913; and **M. v. Laue,** pp. 1575–1579, Dec. 23, 1913.)—Mathematical discussions. E. H. B.

391. *Atomic Structure.* **J. J. Thomson.** (Phil. Mag. 26. p. 1044, Dec., 1913.)—In his recent paper [Abstract No. 14 (1914)] the author supposed that the regions within which the electrical forces inside the atom were supposed to be confined were bounded by conical surfaces. Further investigation shows that the period of a corpuscle inside the region would increase with its energy, and the corpuscle would cease to be in unison with the light before it had acquired enough energy to escape from the region of electrical force. If, however, the boundaries were cylindrical, the period would be independent of the kinetic energy of the corpuscle. The latter would then be in resonance with the light until it had acquired enough energy to escape. Assuming cylindrical surfaces, the results of the paper can apply without further modification. G. W. DE T.

392. *Atomic Dimensions and Constitution.* **A. Heydweiller.** (Ann. d. Physik, 42. 6. pp. 1273–1286, Dec. 23, 1913.)—Determinations of atomic dimensions (1) from the mean free path of a molecule in the normal gaseous state, (2) from the Lorenz-Lorentz refraction equivalents, are compared. Except for monatomic gases, the latter method is susceptible of far less accuracy than the former, but the atomic diameters determined by the two methods do not vary more than 2 % from the means $1{\cdot}663 \times 10^{-8}$ for H, $2{\cdot}765 \times 10^{-8}$ for Cl, and $3{\cdot}185 \times 10^{-8}$ for Xe. For the lower terms of the series of noble gases the discrepancies much exceed the limits of experimental error, and suggest the necessity for a modified theory. The general results are consistent with Kelvin's theory of the atom and with Weiss's magneton theory. They do not support Langevin's diamagnetic theory, which, moreover, requires an improbably large number of electrons in the atom. The ratio of apparent to the true space occupied by the atoms of metals in the solid state leads to a remarkable division into groups, according to the value of the fraction $(M_r - A_r)/A_r$, where M_r is the ratio of atomic weight to density, and A_r is the actual space occupied, as determined by the Lorenz-Lorentz atomic refraction. The values of this fraction as obtained by the author are shown in the accompanying table.

Li	6·43	Mg	4·30	Zn	1·07	Cu	0·615	Mn··	0·319
Na	9·17	Ca	4·29	Cd	1·00	Ag	0·535	Fe··	0·379
K	9·31	Sr	4·77			Th	0·497	Co··	0·305
Rb	8·81	Ba	3·13			Pb	0·371	Ni··	0·431
Cs	7·60								
Means	8·26		4·12		1·04		0·504		0·357

G. W. DE T.

393. *Change with Temperature in Crystal-angles of Quartz.* **F. E. Wright.** (Washington Acad. Sci., Journ. 3. pp. 485–494, Dec. 4, 1913.)—The rhombohedral angle of quartz decreases with rise of temperature up to 575° from 51° 47·4′ to 51° 36·7′. The values agree within 0·1′ with those calculated (*a*) from the coefficient of expansion, parallel to the axis and the change of specific volume of the material, and (*b*) from the exponential formula—

$$y = 51^\circ\ 47{\cdot}4' \left[0{\cdot}0118178t + 0{\cdot}01885\left(e^{\frac{t}{100}} - 1\right)\right]$$

Beyond 575°, at which temperature an inversion takes place, the angle, after showing an abrupt increase, remains almost constant from 600° to 1200°. In taking readings at the highest temperatures it was necessary to use an arc-light to secure a reflected image from the faces, the glow from the furnace being cut off by means of a blue filter. T. M. L.

394. *Gravitation.* **M. Grossmann.** (Archives des Sciences, 37. pp. 13–19, Jan., 1914.)—Deals with mathematical methods and problems relative to the theory of gravitation, the analysis being vectorial. E. H. B.

395. *Gravitation.* **A. Einstein.** (Archives des Sciences, 37. pp. 5–12, Jan., 1914. Phys. Zeitschr. 14. pp. 1249–1262; Discussion, pp. 1262–1266, Dec. 15, 1913, and 15. pp. 108–110, Jan. 15, 1914. Paper read before the 85. Naturforscherversamml., Wien.)—Discusses a possible physical basis of the theory of gravitation with reference to the principle of relativity, and specially on the view that an apparent gravitational field may be replaceable by a state of acceleration of the frame of reference. Part of the paper is mathematical. E. H. B.

396. *Dependence of the Capillary Constants of Water and Alcohol-Water Mixtures on the Temperature.* **M. Reinhold.** (Deutsch. Phys. Gesell., Verh. 15. No. 19. pp. 903–912, Oct. 15, 1913. Extract from Dissertation, Kiel.)—The method employed to determine the capillary constant consists in measuring the wave-length of the capillary waves produced on a freshly-prepared surface of the liquid by means of a vibrating tuning-fork. With the aid of a reading microscope devised by Grunmach the wave-length can be measured to within 0·01 mm. For five mixtures of ethyl alcohol and water containing respectively 94, 70, 50, 30, and 10 per cent. of the alcohol, the dependence of the capillary constant on the temperature between 0° and 65° is expressed by the linear equation, $a = a_0 (1 - \epsilon t)$, where ϵ is the temperature-coefficient. The values of ϵ are 0·000080, 0·000098, 0·000105, 0·000136, and 0·000206 respectively. In the case of water, the method used gives an irregular curve. T. H. P.

397. *Capillarity, Vaporisation and Molecular Size.* **G. Jäger.** (Akad. Wiss. Wien, Ber. 122. 2a. pp. 969–978, May, 1913.)—A mathematical paper in which justification is found for the Thomson method of determining molecular size and for the conclusions drawn by Stefan regarding the relationship between capillarity and vaporisation. The result obtained by the author is also of importance for the determination of size of drops from the velocity of fall of drops in air. A. F.

398. *Meteorological Observations, and Observations at Various Strata of the Atmosphere, obtained on the Lightship "Luzerort."* **M. Rykatchew.** (Acad. Sci. St. Pétersbourg, Bull. 1. pp. 23–40, Jan. 15, 1914. In Russian.)—An account is given of observations taken in the period Aug. 12–24, 1913, on the lightship, which is situated at 57° 38′ N. lat. and 21° 36′ E. long. (of Greenwich).

TIME.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Temperature of Air, °C.																								
By thermograph Kuznatsof	15·1	14·8	14·7	14·9	14·7	14·9	15·0	15·2	15·5	15·7	15·7	16·0	16·0	16·1	16·2	16·3	16·4	16·2	16·2	16·1	16·2	15·9	15·8	16·0
By psychr. Ass. at 6 m. ...	—	—	—	—	—	—	15·1	15·3	15·6	15·8	15·9	16·0	16·1	16·2	16·3	16·4	16·5	16·4	16·3	16·2	16·2	—	—	—
By psychr. Ass. at 4 m. ...	—	—	—	—	—	—	15·4	15·5	15·8	16·2	16·3	16·3	16·5	16·5	16·7	16·9	17·0	16·7	16·6	16·4	16·5	—	—	—
By psychr. Ass. at 1–5 m.	—	—	—	—	—	—	15·4	15·5	15·8	16·0	16·1	16·1	16·3	16·4	16·7	16·9	17·0	16·8	16·6	16·4	16·4	—	—	—
Temperature of Water, °C.																								
Surface (mean 8 days) ...	—	—	—	—	—	—	16·0	—	16·1	—	16·1	—	16·2	—	16·3	—	16·3	—	16·2	—	16·0	—	—	—
Surface (mean 10 days) ...	—	—	—	—	—	—	16·0	—	16·1	—	16·2	—	16·2	—	16·2	—	16·2	—	16·2	—	16·0	—	—	—
Depth 15 ft. (mean 8 days)	—	—	—	—	—	—	16·0	—	16·1	—	16·1	—	16·2	—	16·2	—	16·2	—	16·2	—	16·0	—	—	—
Depth 15 ft. (mean 10 days)	—	—	—	—	—	—	16·0	—	16·0	—	16·1	—	16·2	—	16·2	—	16·2	—	16·1	—	16·0	—	—	—
Depth 30 ft. (mean 8 days)	—	—	—	—	—	—	16·1	—	16·1	—	16·1	—	16·2	—	16·2	—	16·3	—	16·2	—	16·2	—	—	—
Depth 30 ft. (mean 10 days)	—	—	—	—	—	—	16·1	—	16·1	—	16·0	—	16·2	—	16·2	—	16·2	—	16·2	—	16·1	—	—	—
Depth 45 ft. (mean 8 days)	—	—	—	—	—	—	15·0	—	14·9	—	14·9	—	15·4	—	15·6	—	15·8	—	15·7	—	15·7	—	—	—
Depth 45 ft. (mean 10 days)	—	—	—	—	—	—	14·1	—	14·0	—	14·1	—	14·5	—	15·2	—	15·1	—	14·9	—	14·9	—	—	—
Depth 60 ft. (mean 8 days)	—	—	—	—	—	—	14·8	—	14·8	—	14·7	—	14·8	—	15·5	—	14·9	—	14·7	—	14·8	—	—	—
Depth 60 ft. (mean 10 days)	—	—	—	—	—	—	13·8	—	13·8	—	13·8	—	14·0	—	14·7	—	14·2	—	14·0	—	14·1	—	—	—

In addition to the usual observations, the temperatures of the water at depths of 15, 30, 45, and 60 ft. were regularly measured. Further, by the use of kites, records of temperature, humidity, and wind velocity were secured for each 100 m. of ascent up to 1200 m. Results are tabulated. Some are given herewith. On the lightship the Kuznetsof thermohygrograph and the Assmann psychrometer were employed. Precautions taken to secure accuracy are fully described. E. O. W.

DAILY COURSE OF THE ELEMENTS REGISTERED BY KITE FLIGHTS, AUG. 22, 1913.

Time	Temp. °C.	Humidity, %.	Velocity of Wind, m./sec.	Time.	Temp. °C.	Humidity, %.	Velocity of Wind, m./sec.	Time.	Temp. °C.	Humidity, %.	Velocity of Wind, m./sec.
	6 M.				100 M.				500 M.		
h. m.	°			h. m.	°			h. m.	°		
9 30m	16·0	91	7	9 35m	15·0	93	7	9 47m	11·7	97	7
10 58	16·2	92	8	10 56	15·1	94	8	10 50	11·3	99	7
1 37a	16·5	89	7	1 41a	15·6	90	7	1 56a	12·1	95	8
3 12	16·6	92	6	3 11	15·5	94	7	3 5	12·0	97	8
5 2	16·6	90	6	5 4	15·6	92	7	5 13	11·8	98	9
6 27	16·3	91	8	6 25	15·3	93	8	6 17	11·9	100	8
	900 M.				1100 M.				1200 M.		
h. m.	°			h. m.	°			h. m.	°		
10 3m	9·3	93	8	10 10m	8·1	90	8	10 14m	7·4	89	9
10 42	8·8	97	7	10 38	7·5	97	8	10 36	6·8	97	8
2 11a	8·6	99	9	2 15a	8·0	89	9	2 16a	7·8	84	9
2 58	9·3	93	8	2 53	8·3	87	9	2 51	7·6	84	9
5 25	9·2	98	9	5 32	7·8	99	10	5 35	7·2	99	11
6 8	9·0	98	9	6 4	7·6	98	10	6 1	7·8	89	10

399. *Actinometry during Total Solar Eclipse, April* 17, 1912. **F. Lindholm.** (Ark. för Mat. Astron. och Fysik, Stockholm, 8. No. 21. pp. 1–11, 1913.)—Observations were made with two Ångström compensation pyrheliometers, and the record of obscuration of the sun's disc during the progress of the eclipse was obtained by a Steinheil objective of 2·5 m. focal length provided with an enlarging lens, giving a solar image 6 cm. diam. One of the pyrheliometers was used to record the total radiation, and the other to show the blue-violet radiation passing a special screen. Tables are given of the readings taken, and the results are also plotted showing the curves of variation. C. P. B.

400. *The Relations between the Aperiodic Variations of Pressure and Temperature.* **J. v. Hann.** (Meteorolog. Zeitschr. 30. pp. 523–532, Nov., 1913. Extract.)—The theory formerly in vogue that changes of pressure are due to corresponding changes of temperature in the contrary direction, is shown to be untenable by a consideration of the day-to-day variations of the two elements in different parts of the world, both over the interior of continents and in maritime countries. The greatest day-to-day changes of temperature occur over the interior of large continents, the least at stations situated on the sea. On the other hand, for any particular latitude, the max. day-to-day pressure-changes occur over the oceans, the least over the interior of continents. The diminution of the magnitude of the pressure-changes as one passes within a continent is ascribed to the friction of the earth's surface upon the winds forming the circulation within the area of a barometric minimum. [See Abstract No. 1784 (1913).] R. C.

401. *Meteorology: A Return to Normal Atmospheric Transparency.* **H. H. Kimball.** (Washington Acad. Sci., Journ. 4. pp. 17–25, Jan. 19, 1914.)—Attention has already been drawn to the widespread decrease in atmospheric transparency which followed the eruption of Katmai volcano (Alaska) in June, 1912 [see Abstract No. 1254, 1913)]. For the purpose of tracing the gradual return to normal transparency the records of solar radiation and polarisation of skylight at Mount Weather and Madison for individual months since June, 1912, are compared with the average value for the month derived from observations prior to the eruption. Curves showing the departure from mean value of these two elements show very similar results, with a decided maximum departure in Aug., 1912, and thereafter a gradual return to normal conditions in Dec., 1913. It is concluded that the main part of the dust thrown up by the eruption had been precipitated from the atmosphere by the end of 1913. The duration of the dust-cloud was thus markedly less than the duration (three years) of that which followed the Krakatoa eruption in 1883. J. S. Di.

402. *Vertical Temperature Gradients between Mount Weather, Va., and Valley Stations.* **A. J. Henry.** (Mount Weather Observatory, Bull. 6. pp. 85–87, 1913.)—Since this subject was last discussed [see Abstract No. 997, 1912)] further data have become available. It is found from the means of this longer series of observations that the vertical temperature gradients between the mountain and the three valley stations are least in winter (0·58°, 0·30°, and 0·27° C. per 100 m. to the three stations) and greatest in summer (0·68°, 0·49°, and 0·48° respectively). The minimum gradient between Mount Weather and each of the low-level stations occurs in January. J. S. Di.

403. *Universal Thermometer Screen for the Determination of Air Temperature and Humidity, for use at Meteorological Stations.* **W. Köppen.** (Meteorolog. Zeitschr. 30. pp. 474–488, Oct., and pp. 513–523, Nov., 1913.)—The errors of the screens in general use in Europe are described. The Stevenson screen adopted for the British Isles provides the best exposure of these if the ventilated Assmann psychrometer be taken as standard. On days and nights with strong radiation the Stevenson screen gives values of maximum and minimum temperature which are slightly too high and too low respectively. The Glaisher stand and French screen, which merely protect the instruments against direct solar radiation, are less satisfactory in comparison with that standard. In this type of screen the maxima and minima are higher and lower respectively than corresponding readings in a Stevenson screen on days of strong radiation. The Wild screen, which is very large but entirely covered in, gives values of maxima and minima which are both too high in comparison with the Assmann standard. The exposure on the north wall of a house, much used in Germany, is not good, the temperature maxima obtained there being too low and the minima too high. All the exposures become more satisfactory as the velocity of the wind increases from a calm.

The points to be considered when designing a screen for the determination of the true air temperature are:—(1) The screen must protect the thermometers from damage, rain, and radiation, but must allow a free passage of air through it. (2) The longer the path of the air through parts of the screen which are heated by radiation, the more likely is the temperature of the air to be affected as it passes through. (3) The greater the capacity for heat of a body, the more will variations in the temperature of any impinging air be diminished and retarded. It follows (1) that the material of a screen should possess a small coefficient of emission and absorption, and that it should be a bad conductor of heat. (2) The dimensions of the sides of the screen through which most of the air passes should be as small as possible, and the velocity of the air through the screen should be as great as possible. (3) The mass and heat capacity of all parts which can influence the temperature of the air should be made as small as possible.

The Stevenson screen fulfils these conditions fairly well. The author puts forward the following modifications of it which are intended to make its use applicable to all countries with satisfactory results. At the same time the modifications permit of the installation in the screen of a thermo-hygrograph instead of the maximum and minimum thermometers if desired, the complete equipment in that case being the thermo-hygrograph and dry- and wet-bulb thermometers. The three lower louvres of the east side of the screen are removed parallel to themselves to a position nearer the west side, and a second perforated floor is introduced above them so that the screen becomes divided into two parts: a large upper portion which contains the clock drum and pens of the thermo-hygrograph and the stems of the thermometers, and a small lower portion on the west side which contains all the parts of the instruments which require most protection from radiation, viz., the bimetallic thermometer, the hair of the hygrograph, and the bulbs of the thermometers. In addition to these changes a straw roof to the screen is recommended; also a straw shelter to shade the whole of the screen from direct solar radiation. This shelter varies in shape and position according to the latitude of the station. Experiments are being made in Switzerland to test the capacity of this type of screen to withstand the intense solar radiation there experienced. It will be observed that the lower portion, *i.e.* the screen proper, is of very small dimensions, while allowing of the free ingress and egress of the air. R. C.

404. *Solar Radiation.* **F. W. Very.** (Amer. Journ. Sci. 36. pp. 609-635, Dec., 1913.)—There are two methods of measuring solar radiation. The first, the actinometric, is the most direct and has been most generally employed; but the author prefers the second method, the spectro-bolometric, as giving rise to fewer uncertainties in the determination of the solar constant. This method traces the distribution of energy in the solar spectrum, determines the wave-length of the maximum point in the spectral energy curve, and infers by theory the temperature and radiating power of the solar surface, from which the intensity of the radiation at the earth's distance is at once known. Taking the most reliable figures available by this method, it is concluded that the effective temperature of the sun is about 6800° abs., from which the value 3·5 gm.-cals. per cm.^{2} per min. for the solar constant is deduced. The very much lower values which have been obtained by the actinometric method are ascribed to inadequate corrections for the absorption due to water-vapour in the air. There has been difficulty in finding any suitable formula to connect the loss of solar radiation in passing through the atmosphere with the vapour pressure at the surface. The author puts forward a table of corrections which lead to consistent values of the solar constant under widely different degrees of vapour pressure at the surface, and he concludes that these tables may be regarded as satisfactory for obtaining a mean corrected value from many measurements. Individual determinations must always be liable to error, since the surface vapour pressure cannot be a reliable guide to the total vapour contents of the atmosphere. When these suggested corrections are applied to existing actinometric measurements a value of the solar constant in excess of 3 gm.-cals. is obtained. The final conclusion is reached that the value of the solar constant is certainly not less than 3 and may be as large as 4 gm.-cals. per cm.^{2} per min. A large fraction of this radiation is absorbed in the upper layers of the atmosphere, so that not more than 2 gm.-cals. reach the tops of the highest mountains. J. S. Di.

405. *Conduction of Heat in "Pseudo-isotropic" Earth.* **A. v. Anderkó.** (Meteorolog. Zeitschr. 30. pp. 580–589, Dec., 1913.)—By a "pseudo-isotropic" earth the author means earth which changes either periodically or at irregular intervals in its coefficient of conductivity, its density, and its specific heat, owing to admixture with varying amounts of water, which originates either as rain or as underground water. The paper is a mathematical discussion of the temperature conditions in such an earth, and it is illustrated by examples drawn from the observations of earth-temperature made in Tiflis and Pawlowsk. R. C.

406. *The Barometric Gradient as a Secondary Cause of Earthquakes.* **K. Hasegawa.** (Mathematico-Physical Soc., Tōkyō, Proc. 7. pp. 181–185, Nov., 1913.)—The paper contains an investigation of the possible connection between a local earthquake and the atmospheric condition prevailing just before the occurrence of the shock. The author has selected fifty local earthquakes which occurred at Gihu from 1904 to 1906. Comparing the atmospheric pressure at Gihu with the pressures at a few surrounding stations a few hours before each earthquake, the author finds that the current pressure at Gihu was neither higher nor lower in all the cases than at these stations. He next examined whether an abrupt change of atmospheric pressure may be a secondary cause of local earthquakes, but could not draw any definite conclusion owing to the scantiness of data available. Finally he investigated the baric gradient at Gihu at a time about 30 minutes before the occurrence of each local earthquake, using T. Okada's graphical method; two sets of tables are given. The conclusion is drawn that it is highly probable the gradient of the atmospheric pressure prevailing shortly before the occurrence of a local earthquake may be a secondary cause of the same. H. H. Ho.

407. *Absorption and Polarisation of Sunlight.* **A. Boutaric.** (Acad. Roy. de Belgique, Bull. No. 7, 1913. Le Radium, 11. pp. 15–26, Jan., 1914.)—Where light is transmitted through a liquid in which a fine precipitate has just been formed, the absorption due to the liquid increases with the time, while the proportion of polarised light in the scattered light at right angles to the incident beam decreases, both changes being due to the increase in size of the precipitated particles. The similar problem of sunlight passing through the atmosphere has been investigated experimentally. The intensity of solar radiation was measured with an Ångström pyrheliometer, and the proportion of polarised light in the sky by means of a Cornu photopolarimeter. The measurements show that for the greater part of the radiation received from the sun the absorption due to the atmosphere is closely connected with the proportion of polarised light in the general light from the sky. C. P. B.

408. *Sun-spot Periodicity as Fourier Series.* **H. H. Turner.** (Roy. Astronom. Soc., M.N. 78. pp. 714–782, Supplementary No., 1918.)—Preliminary trials in the calculation of the Fourier sequence of exact submultiples of 156 years, which is approximately the length of the period for which we have available Wolf's sun-spot numbers. [Abstract No. 89 (1914).] Further study suggests that the method may be preferable to the periodogram method, as from the sequence thus determined the coefficients for any other intermediate periods can be quickly and simply inferred. C. P. B.

409. *Position of Sun's Axis.* **F. W. Dyson** and **E. W. Maunder.** (Roy. Astronom. Soc., M.N. 78. pp. 678–687, 1918.)—From a detailed discussion of the photographs of the sun from 1874–1912, giving positions of sun-spots for measurements made at Greenwich, it is found that small corrections are needed to be applied to Carrington's elements, giving the true positions of the solar equator, for the epoch 1850·0 as $I = 7^\circ\ 10{\cdot}5'$; $N = 73^\circ\ 46{\cdot}8'$. The discordances found between the corrections deduced for short periods, such as a single year, or from spot-groups in restricted zones, are due to the large proper motions of individual groups. A slight tendency is suggested for high-latitude spots in either hemisphere to move away from the equator, but for those in lower latitudes to move towards it. C. P. B.

410. *Sun's Axis of Rotation.* **A. A. Buss.** (Observatory, No. 468, pp. 477–478, Dec., 1918.)—It is suggested that there are only two zones of spot-drift, one on either side of the sun's *physical* equator of a particular period, the drift in both these zones being directed towards the respective pole. It has usually been stated that spots between 20° N. and 20° S. latitude appear to approach the equator, while those outside these limits show a pronounced tendency to move poleward. It is possible, therefore, that a distinction should be recognised between the sun's *physical* and its *geographical* equator. C. P. B.

411. *Equatorial Acceleration of the Sun.* **Fessenkoff.** (Comptes Rendus, 157. pp. 884–887, Nov. 10, 1918.)—Assuming the presence of a heterogeneous fluid mass, subject to gravitational attraction of its parts, with a uniform rotation, an analysis is given of the variations of surface-level following on a certain supposed distribution of internal densities. From this is deduced a formula giving the angular velocity of rotation, and the computed values are compared with those actually observed. C. P. B.

412. *Radial Motion in Sun-spots.* **C. E. St. John.** (Astrophys. Journ. 38. pp. 341–391, Nov., 1918. Contribution from the Mt. Wilson Solar Observatory, No. 74.)—In a previous paper [Abstract No. 194 (1914)] the displacements at the peripheral edges of the spot penumbræ were given for some 500 solar lines. The present paper continues and amplifies the discussion, with tables showing the various velocities found for lines of varying origin and intensity. These differing displacements shown by the Fraunhofer lines at the edges of penumbræ of eccentrically situated sun-spots seem to find their simplest explanation in movements of the solar vapours tangential to the solar surface with velocities varying with the elevation. The H_3 and K_3 lines of calcium are of the highest level, followed by the H_α line of hydrogen, and in general it may be said that the heavy and rare elements occur in detectable amounts only in the lower portions of the solar atmosphere. The enhanced lines show smaller radial displacements than unenhanced lines of

the same solar intensities, and would appear to originate in higher levels in and near sun-spots. The results also link up satisfactorily with the observations of rotation and magnetic separation of lines. C. P. B.

413. *Gravitational Instability and the Nebular Hypothesis.* **J. H. Jeans.** (Roy. Soc., Phil. Trans. 218. pp. 457–485, Feb. 2, 1914.)—This is an inquiry how far researches, *e.g.* of Maclaurin, Jacobi, Poincaré, and Darwin, into rotating matter assumed homogeneous and incompressible, may be expected to give approximations to the behaviour of the actual matter of astronomical systems. *A priori*, wide differences would be expected. But the complexity of the general stability problem for a sphere of actual matter is greatly reduced by the considerations that—Every change in elastic energy involves an increase in potential energy, while every change in gravitational energy involves a decrease in potential energy, so that the stability condition is that for every possible displacement the former shall exceed the latter. It appears to be a general law that, apart from artificially constructed systems, the elastic and gravitational energies march together, so that the stability condition is fulfilled. Thus every natural spherical system is found to be stable. Inquiring how far rotation can disturb this stability, the ideal incompressible mass is found to supply a surprisingly good model of the actual systems. The results so far achieved make it probable that up to the first appearance of instability the actual mass will behave almost exactly as the model, passing, as rotation increases, through a series of flattened configurations very similar to the Maclaurin spheroids, and from them to the Jacobean ellipsoids. A vibration will be stable if thegain in elastic energy exceed the loss in gravitational energy. Now the latter is practically determined by the vibrations of greatest wave-length, while the former is affected to nearly the same extent by all vibrations. Instability can therefore enter only through disturbances of greatest possible wave-length, and these are identical for compressible and incompressible spheres. G. W. DE T.

414. *Albedo of the Earth.* **F. W. Very.** (Astronom. Nachr. No. 4696. Nature, 92. p. 486, Dec. 25, 1913. Abstract.)—An attempt is made to determine the albedo of the earth from visual observations of the earth-shine on the moon, in comparison with light from similar sun-illuminated areas on the moon's surface; the resulting value is $A_e = 0{\cdot}89$. C. P. B.

415. *Brightness of the Reflected Rays from Brooks's Comet* (1911*c*). **S. V. Orlov.** (Acad. Sci. St. Pétersbourg, Bull. 2. pp. 151–154, Feb. 1, 1914. In Russian.)—The author gives an account of his attempt to calculate the brightness of the reflected solar rays (evidenced by the continuous spectrum), as distinct from that of the nucleus of Brooks's comet itself. For purposes of this investigation were taken the photometric observations of Bemporad on the brightness of the nucleus, secured by aid of a Toepfer wedge photometer used with a Cooke equatorial of 15 cm. aperture and 223 cm. focal length, with magnifying power of 75. The desired magnitudes of the mean brightness of the reflected rays, of those originating in the nucleus, and the variable brightness were determined by the equations derived from the method of least squares. The brilliancy of the comet, as in the case of that of Encke-Backlund was notably greater as it approached perihelion than after. A curve is given exhibiting the data obtained by the author, based on a star of 9·83 mag. as unit; for comparison a curve is also given showing the mean indication of the brightness of the nucleus according to Bemporad. The two curves

show good agreement; they relate to the period Aug. 10 to Oct. 29. The brightness of the reflected rays from the nucleus of Brooks's comet may be taken as approximating to that of its own brightness, and nearly equal to 8·8 mag. E. O. W.

416. *Terrestrial Refraction.* **C. V. L. Charlier.** (Comptes Rendus, 157. pp. 831–834, Nov. 10, 1913.)—Formulæ are developed connecting the differential refraction with different heights and the physical constitution of the atmosphere. C. P. B.

417. *Zodiacal Matter and Solar Constant.* **E. Belot.** (Comptes Rendus, 157. pp. 757–760, Nov. 3, 1913.)—An exponential law for the planetary distances is considered to give better interpretation of the natural facts than the older Bode's law, and assigns theoretical distances to five zones of asteroids which would appear to account for many of the facts of observation very closely. One of these rings is found to correspond to an elongation of 35° for the brightest part of the zodiacal light, and this is very near the value observed by Newcomb at the summit of the Rothhorn. An interesting computation is given in illustration of the possible effect of such a zone on the absorption of the solar radiation, and the variations predicted appear to have some relation to the variations found by Abbot, Fowle, and Aldrich from observations of the solar constant in California and Algeria. C. P. B.

418. *Magnifying Powers for Double-star Observers.* **T. Lewis.** (Observatory, No. 467, pp. 423–428, Nov., 1913.)—Diffraction effects begin to deteriorate the definition in a telescopic combination when the magnifying power is greater than the number of mm. in the diam. of the object-glass (Whittaker "Optics"). In the case of resolution of two stars in close proximity, the fact of a star image being a small disc, and not a point, becomes of considerable importance. A series of six determining factors are discussed in their bearing on the practical observation of double-star separations. After this tables are given showing the examination of the instrumental constants of well-known double-star observers, using instruments with objectives varying from 3·8 to 36·0 in. in diam. From this it appears that the best practical magnification may be calculated from the formula $M = 140\sqrt{A}$, where M = magnifying power, and A is the diam. of the objective in inches. C. P. B.

419. *Stellar Spectra with Bright Hydrogen Lines.* **P. W. Merrill.** (Lick Observatory, Bull. No. 237. Nature, 92. p. 354, Nov. 20, 1913. Abstract.)—A photographic survey has been made at the Lick Observatory of all stars of Class B whose spectra show bright hydrogen lines, and which are north of declination —40°. Tests were made on two stars for evidence of polarisation in the H_β line, with negative results. C. P. B.

420. *Photographic Spectra of Class A Stars.* **E. P. Waterman.** (Lick Observatory, Bull. No. 243. Nature, 92. p. 354, Nov. 20, 1913. Abstract.)—From a study of a number of the brighter Class A stars it is agreed that Miss Cannon's proposal to rearrange their classification is advisable. The metal lines found present are the enhanced or special spark-lines, agreeing in wave-length and intensity with the lines of the solar chromosphere. C. P. B.

421. *Later Spectrum of Nova Geminorum No. 2.* **W. S. Adams** and **J. B. Lasby.** (Roy. Astronom. Soc., M.N. 73. pp. 742–744, 1913.)—The paper deals principally with the sequence of variations of intensity of the line λ4686. The structure of the band at this wave-length is precisely like that of the hydrogen and nebular bands, consisting of two equal maxima at the edges of the band separated by a broad faint absorption band which lies symmetrically on it. Allowing for the variations in density of the negatives, the widths and the positions of the centres of both the hydrogen and the nebular bands have remained remarkably constant throughout the entire series of observations, extending from 1912 May 10 to 1913 April 27. C. P. B.

422. *Orbits of λ Tauri and φ Persei.* **F. Schlesinger, F. C. Jordan,** and **A. H. Pfund.** (Allegheny Observatory, 3. Nos. 4, 5, 6. Nature, 92. p. 460, Dec. 18, 1913. Abstract.)—Notes of spectroscopic observations of eclipsing variables, with details of the velocity curves. C. P. B.

423. *Statistics of Nebulæ and Clusters.* **C. V. L. Charlier.** (Ark. för Mat. Astron. och Fysik, Stockholm, 9. 15. pp. 1–35, 1913.)—The investigation has been carried out at the Lund Observatory, with the object of determining the distribution of the nebulous stars in space. Information regarding the co-ordinates, brightness, size and form of the various objects has been collected, and the various tabulations are discussed in detail; illustrations are also given showing graphically the distribution with regard to the Milky Way. C. P. B.

424. *New Nebulæ and Variable Stars.* **C. R. D'Esterre.** (Astronom. Nachr. No. 4697. Nature, 92. pp. 434–435, Dec. 11, 1913. Abstract.)—Observations of an abnormal object exhibiting a long period of brightness and rapid decline which may be a new variable or nova. Also of several new nebulæ in the neighbourhood of I Cassiopeiæ. C. P. B.

425. *Parallax of Binary Systems.* **S. G. Cederstrand.** (Ark. för Mat. Astron. och Fysik, Stockholm, 8. No. 34. pp. 1–24, 1913.)—The published observations of the positions of the binary systems Σ_3 and Σ_4 are discussed for the investigation of their parallax. C. P. B.

426. *Radial Velocity of Andromeda Nebula.* **V. M. Slipher.** (Lowell Observatory, Bull. No. 58. Nature, 92. p. 411, Dec. 4, 1913. Abstract.)—From a series of spectrograms obtained with exposures of from 6h. 50m. during Sept., Nov., and Dec., 1912, the mean radial velocity of the Andromeda nebula is given as −300 km. per sec. C. P. B.

LIGHT.

427. *Total-reflection Prism.* **K. Pritschow.** (Zeitschr. Instrumentenk., Beib. 21. pp. 221-227, Nov. 1, 1913.)—Describes, with diagrams, a special form of total-reflection prism ("Dachprisma"). Used with a simple eyepiece and objective we have a telescope similar in action to a terrestrial telescope, giving no inversion of the object, but simply changing the line of view from (say) the vertical to the horizontal. Such an instrument could be used with advantage in observing airships, etc. Another form may be used with an ordinary total-reflection prism for direct vision, while others change the view line through angles depending on the angle of the prism. For diagrams and details see original paper. A. W.

428. *Process for Stereoscopic Kinematography.* **J. Sahulka.** (Elektrotechnik u. Maschinenbau, 32. pp. 37-38, Jan. 11, 1914.)—Two films are exposed in a stereoscopic camera. Pictures from these films alternately, are thrown on to a single screen, the projectors being so adjusted that the successive pictures occupy exactly the same position on the screen. Each spectator views the pictures through a binocular with a revolving disc in front of it. This disc is driven by a motor running in synchronism with the film-driving motor and has slots in it which are arranged to leave each eye unobstructed at the instant its own picture is on the screen.

F. T. C.

429. *Reflection of Light at the Confines of a Diffusing Medium.* **Rayleigh.** (Nature, 92. p. 450, Dec. 18, 1913.)—An experimental and mathematical treatment of the problem as suggested by the beautifully graded illumination of a paraffin candle, extending downwards from the flame to a distance of several inches. The effect is seen at its best when there is but one candle in an otherwise dark room, and when the eye is protected from the direct light of the flame. And it may be noticed when a candle is broken across, so that the two portions are held together merely by the wick, that the part below the fracture is much darker than it would otherwise be, and the part above brighter, the contrast between the two being very marked. This effect is naturally attributed to reflection, but it does not at first appear that the cause is adequate, seeing that at perpendicular incidence the reflection at the common surface of wax and air is only about 4 per cent. A little consideration shows that the efficacy of the reflection depends on the incidence not being limited to the neighbourhood of the perpendicular. The mathematical treatment explains the observed facts of diffusion, by far the greater part being due to total reflection which ensues on oblique incidence in the wax.

E. H. B.

430. *Phase-variation of Light Totally Reflected.* **S. Rybár.** (Ann. d. Physik, 42. 6. pp. 1171-1195, Dec. 23, 1913.)—A review is given of previous work, and it is pointed out that hitherto experimental methods have only given the difference of phase of the incident and reflected rays. The present method gives the absolute phase-variation of the parallel and perpendicular components of the incident ray. The arrangement of apparatus appears to

be suited for the investigation of other questions besides that here dealt with. An elementary theory of the method is presented, which is only valid for the cases with which the present work is concerned—namely, for the parallel and perpendicular components of the totally reflected light. The experimental results have been compared with Fresnel's theory in a detailed quantitative manner, and complete agreement was obtained. A detailed, though only qualitative, investigation was also made whereby the well-known facts of the variation of phase of the light reflected from optically dense media at about 180° were confirmed. A. W.

431. *Scattering in the Case of Regular Reflection from a Transparent Grating.* **C. Barus.** (Nature, 92. pp. 451–452, Dec. 18, 1913.)—A beam of light from a collimator is reflected from the two faces of a plate-glass grating having about 10,000 or more lines to the inch, the ruled surface being towards the source. It is found that relatively more blue light is regularly reflected from the ruled surface than is transmitted, and more reddish light transmitted than is reflected. The phenomenon is strictly regular reflection, *i.e.* there is a wave-front, for the blue and the yellow slit-images are absolutely sharp in a telescope. This latter feature associates the phenomenon with the recent discovery of Friedrich, Knipping, and Laue relative to the reflection of X-rays from the molecules of crystals. The author gives a theoretical consideration based on the idea that the wave-fronts of regularly reflected and scattered light are superposed. E. M.

432. *Non-selective Transmissibility of Radiation through Dry and Moist Air.* **F. E. Fowle.** (Astrophys. Journ. 38. pp. 392–406, Nov., 1913.)—An account is given of the determination of non-selective absorption of radiation between the wave-lengths 0·34 μ and 1·7 μ associated with atmospheric aqueous vapour and of the general transmission coefficients for radiation passing through a dry atmosphere. The method consists of the correlation of the atmospheric scattering of solar radiation with the amount of water-vapour present. The transmission coefficient for dry air is then used for the determination of the number of molecules, N_0, per cm.³ of a gas at 760 mm. pressure and at 0° C. This result gives $N_0 = 25{\cdot}6 \times 10^{18}$. This mode of analysis shows that, except when selective absorption occurs, the depletion of the beam from the sun as observed in 1910 and 1911 at Mount Wilson, was caused almost wholly by molecular scattering. The same analysis applied to atmospheric aqueous vapour shows that the observed absorption is very much too great to be accounted for by the number of water molecules present; and leads to the idea of the vapour being loaded with something greater than molecules. [See Abstract No. 1981 (1913).] C. P. B.

433. *Absorption of Ultra-violet Light by Inorganic Salts.* **T. Retschinsky.** (Ann. d. Physik, 42. 6. pp. 1580–1588, Dec. 23, 1913.)—Absorption-spectrum curves are given for lithium and sodium chlorides, bromides, iodides, and nitrates in the range from 400 to about 200 $\mu\mu$. In many cases an actual absorption band (max. absorption) is observed between wave-length 300 and 250 $\mu\mu$. In cases where this is absent there is a very marked "step-out" in the curve; thus even the chlorides give absorption-curves which are practically horizontal from 300 to 250 $\mu\mu$. The observations are in accord with those of Lübben on the dispersive power of dissolved salts, according to which there are "free-periods" corresponding with wave-length 165 $\mu\mu$ for chlorides, 186 $\mu\mu$ for bromides, and 238 $\mu\mu$ for iodides. T. M. L.

434. *Tyndall Phenomenon in Gelatine Solutions.* **L. Arisz.** (Konink. Akad. Wetensch. Amsterdam, Proc. 16. pp. 381–386, Oct. 24, 1913.)—The intensity of the Tyndall phenomenon in gelatine solutions kept at constant temperature undergoes gradual increase. This change occurs with the sol- as well as with the gel-condition, and sometimes occupies several days, the solution approaching an equilibrium determined by the temperature. The influence of the temperature varies with the concentration of the gelatine solution. With 1 per cent. and 2 per cent. gelatine solutions, the intensity of the phenomenon is not influenced by raising the temperature above about 30°, but below 30° the intensity increases markedly as the temperature is lowered. With more concentrated solutions, the influence of temperature shows itself at higher temperatures. T. H. P.

435. *Refractive Index of Gaseous Mixtures.* **S. Valentiner** and **O. Zimmer.** (Deutsch. Phys. Gesell., Verh. 15. 24. pp. 1301–1316, Dec. 30, 1913.)—Describes experiments, made by the interference method, on the refractive index of the two mixtures (i) He—Ne—H and (ii) CO_2—H. Various proportions of the constituent gases were used in both cases. The accuracy of the apparatus was tested by some observations on dry air freed from CO_2. Several modifications were introduced into the apparatus particularly to secure an even temperature throughout the gas chambers. Observations were made by varying the pressure of the gas under observation until the null-point of the compensator was nearly reached. The actual "null" pressure was then obtained by interpolation, and the refractive index calculated from the equation $(n_2-1)=(n_1-1)\,.\,p_1T_2/p_2T_1$, where n_1, p_1, T_1, and n_2, p_2, T_2 are the refractive indices, pressures, and temperatures of the two gases to be compared. The results for the two above mixtures are tabulated and the experimental error is given as ± 0·2% for a pure gas and ± 0·7 % for a mixture. The agreement with the values calculated from the Lorenz–Lorentz formula is, in general, good. In the case of mixture (ii), however, the refractive index is slightly but distinctly smaller than is to be expected from the formula. The refractive index found for pure dry air is 1·0002931 (wave-length 0·578 μ). J. W. T. W.

436. *Constancy of Velocity of Light.* **W. de Sitter.** (Konink. Akad. Wetensch. Amsterdam, Proc. 16. pp. 395–396, Nov. 27, 1913.)—In an earlier note [Abstract No. 1418 (1913)] the author pointed out that the existence of spectroscopic doubles whose motion obeys the laws of Kepler, is incompatible with the theory of Ritz, while it may be in agreement with the theory of Lorentz. A calculation is now made of the upper limit assignable to the coefficient of the possible term depending on the source velocity, giving this as $< 0·002$, for stars with parallaxes $< 0·05''$. C. P. B.

437. *Tyndall Phenomenon.* **E. Wilke** and **H. Handovsky.** (Ann. d. Physik, 42. 6. pp. 1145–1158, Dec. 28, 1913.)—An experimental research on the scattering of light shown by Tyndall and mathematically treated by Rayleigh (in 1871). An arrangement is described by which may be measured the intensity of the Tyndall light for different thicknesses of the illuminated layer. It is thus shown that the falling off in the light in the Tyndall layer follows an exponential law. The attenuation exponent is dependent on the ratio of the two intensities, that of the scattered and that of the incident light. This exponent depends also on the chemical properties of the illuminated substance. E. H. B.

438. *Strain in Large Glass Bodies due to their own Weight.* **E. Zschimmer.** (Zeitschr. Instrumentenk. 33. pp. 376–378, Dec., 1913.)—An investigation was made of the double refraction resulting from strain due to their own weight in the case of glass discs 27 cm. in diam. and 3 cm. thick. The method of Mach and Fritsch was used to obtain photographs, a number of which are reproduced. A. W.

439. *Radiation-pressure.* **H. L. Callendar.** (Nature, 92. pp. 450–451, Dec. 18, 1913.)—The theory recently outlined by the author [Abstract No. 286 (1914)] leads to the conclusion that "the total pressure of full radiation should be one-third of the intrinsic energy density, but this could not be true for the partial pressure of each component taken separately." On the gas analogy the vibrations should be adiabatic, in which case $pv =$ constant would involve the impossibility $(E + pv)/E =$ (total energy)/(intrinsic energy) $=$ unity. Therefore analogy is false, or, if the vibrations are adiabatic, the ratio may have different values for different frequencies. Since the index $\gamma = (E + pv)/E$, $p = (\gamma - 1)E/v$, as Rayleigh found for monatomic gases [Abstract No. 1248 (1905)]. According to the author's theory, $\gamma - 1$ must be of form T/bv, which is different for different frequencies. This could be tested experimentally thus:—Divide the radiation from a source into two parts of different frequencies: compare total energies and pressures. Then in the author's theory, the part of lower frequency should have the higher pressure in a determinate ratio, while on Maxwell's theory the ratio of pressure to energy should be the same for each part. (Ibid. p. 500, Jan. 1, and pp. 629–630, Feb. 5, 1914.)—Replying to correspondence following on the above publication, the untenability of the simple relation—pressure = one-third of energy density always—is shown thus:—Admittedly, total heat in emission, or absorption, of unit volume of radiation $= E/v + p$. This, by Carnot's principle, $= T(dp/dT)$. Whence, if $E/v = 3p$, the fourth-power law for full radiation follows. If true for each separate frequency, constant-frequency radiation should increase with temperature according to fourth-power law. It does not. Therefore either Carnot's principle is inapplicable or E/v does not equal $3p$ for each separate frequency. The author prefers the latter alternative.

The formula $E_\lambda = 8\pi R\lambda^{-4}T/N$, a necessary consequence of electromagnetic equations from which $E/v = 3p$ was first deduced, is so in conflict with experiment, except for long waves and high temperatures, as to suggest something overlooked in application or interpretation of equations.

Nichols and Hull's experimental proof that pressure of a beam of light equals energy-density irrespective of wave-length accords with the author's theory, according to which the mechanical effect they measured should equal $E/v + p$, as deduced from their energy measurements. The suggested measurement of p separately from E/v may, however, prove difficult, or even impracticable. **C. G. Darwin** (Ibid. p. 585, Jan. 22, 1914). G. W. DE T.

440. *Pressure of Radiation and Carnot's Principle.* **Rayleigh.** (Nature, 92. pp. 527–528, Jan. 8, 1914.)—As is well known, the pressure of radiation, predicted by Maxwell and experimentally confirmed by Lebedew and by Nichols and Hull, plays an important part in the theory of radiation developed by Boltzmann and W. Wien. The existence of the pressure according to electromagnetic theory is easily demonstrated, but it does not appear to be generally remembered that it could have been deduced with some confidence from thermodynamical principles, even earlier than in the time of Maxwell.

Such a deduction was, in fact, made by Bartoli in 1876, and constituted the foundation of Boltzmann's work. Bartoli's method is quite sufficient for his purpose; but, mainly because it employs irreversible operations, it does not lend itself to further developments. The present paper then details the elementary argument on the lines of Carnot, by which it appears that in the absence of a pressure of radiation it would be possible to raise heat from a lower to a higher temperature.

The imaginary apparatus is, as in Boltzmann's theory, a cylinder and piston formed of perfectly reflecting material, within which we may suppose the complete or black radiation to be confined. The cycle of operations is the same as in Carnot's theory, the only difference being that here, in the absence of pressure, there is no question of external work. The sole result of the cycle is that heat is raised from a lower to a higher temperature. Since this is assumed to be impossible, the supposition that the operations can be performed without external work is to be rejected—in other words, the radiation must be regarded as exercising a pressure upon the moving piston. Carnot's principle and the absence of a pressure are incompatible. A further discussion is given in a mathematical form. **H. L. Callendar** [Ibid. p. 553, Jan. 15, 1914.] E. H. B.

441. *Luminous Spherical Waves.* **P. Sélényi.** (Comptes Rendus, 157. pp. 1408–1410, Dec. 22, 1913.)—Non-homogeneous plane waves have been known for some time, especially since the researches of Voigt. They are waves in which the plane containing points of equal phase does not coincide with that of the points of equal amplitude, these planes making a certain angle with one another, the value of the amplitude in the plane of equal phases being given by the function $a_0e^{-kl/\lambda}$, where a_0 and k are constants, l the distance from a fixed point of the plane of equal phases, and λ is the wave-length. The most interesting example of these waves is produced in the less refractive medium when there is total reflection at the plane surface of separation of two media. In the present paper the author shows that if light coming from a source situated in a less refractive medium passes into a more refractive medium, a part of this light is propagated outside the cone of total reflection in spherical non-homogeneous waves. Plane waves are first considered, and then similar methods are applied to the second case, expressions being obtained for the factor determining the phase and for the amplitude. The existence of these spherical non-homogeneous waves may be shown by the following arrangement:—On the hypotenuse of a total-reflection prism is placed a drop of a solution of fluorescein; light is allowed to fall on this drop, which becomes fluorescent, and then, the eyes being accommodated to infinity, the surface of the cone of total reflection is observed. It appears then that the luminous intensity is not zero outside the cone, but on the contrary is perceptible to the eye. It results from this that the luminous centres, situated in proximity to the surface of the glass, send some light into the region of space outside the cone, and they send more the nearer they are to the surface. A similar problem arises when the luminous source is a Hertz double pole; it is necessary then to determine the laws of reflection and refraction of the waves which are emitted. This, with other analogous optical phenomena, will be considered in a subsequent paper. A. W.

442. *Photographic Spectrophotometry. Colour Screens.* **J. Baillaud.** (Le Radium, 10. pp. 402–406, Dec., 1913.)—With a luminous source, a photographic plate, and a spectrograph such that the spectrum of the source photographed on the plate presents the same degree of blackening for all radiations, the test of the absorption bands of a screen would be very simple: to interpose the screen between the source and the spectrograph and to examine upon the photograph the degree to which the blackening is diminished for certain radiations, would be all that was necessary. Unfortunately, even the best panchromatic plates have not a constant sensitivity for all radiations, and the distribution of energy in the spectrum of known sources is not uniform. The bands produced by the screen thus mingle with those caused by irregularity in the relative actinism of the plate and of the source, and, hence, their determination is by no means accurate. With the spectrophotometer here described these difficulties disappear. The absorption curve is traced by the apparatus itself in a quantitative as well as a qualitative manner. By its use it is possible to obtain to the tenth about, without measurements, the coefficients of absorption of colouring matter for different radiations. A. E. G.

443. *Influence of Dampness of the Air upon the Constants of the Reichenbach Telemeter.* **H. Samel.** (Zeitschr. f. Vermessungswesen, 42. p. 358, 1913. Zeitschr. Instrumentenk. 33. pp. 379–380, Dec., 1913. Abstract.)—With the object of testing whether changes of moisture in the atmosphere could affect the tension of the spider-threads sufficiently to cause appreciable errors in practice, experiments were made upon a number of tachymeter telescopes from the geodetic collection of Poppelsdorf Academy. Observations were made firstly in air dried by the use of $CaCl_2$, and secondly in air damped by leaving rolls of moist blotting-paper for a considerable time in the vicinity of the instrument. In the second case, indeed, drops of moisture actually hung upon the threads. With one or two trifling exceptions, the differences of the two sets of measures lay within the limits of the errors of observation. Hence the conclusion is drawn that atmospheric changes of moisture do not alter the tension of well-mounted spider threads sufficiently to affect the principal constants. A. E.

444. *Colouring Material of "Ultra-violet" Flowers.* **G. Michaud** and **J. F. Tristan.** (Archives des Sciences, 37. pp. 47–49, Jan. 15, 1914.)—The authors have photographed 90 flowers of all colours through a Foucault screen, which only allowed light to pass through it of wave-length between 3160 and 3260 Å. Each photograph was repeated with an ordinary objective. It was thus found that the very strong absorption of ultra-violet light observed by Wood for some white flowers is a general phenomenon for all flowers that are not yellow. The white corollas, as well as the violet, blue, or red, which were examined, without a single exception all absorb ultra-violet light very strongly, and are of almost a uniform blackness in photographs taken with the Foucault screen. Yellow flowers can be divided sharply into two classes. The first, which includes most with yellow corollas, follow the general rule and give black images in ultra-violet light. The second class, on the other hand, reflect almost totally the ultra-violet light used, and appear white when photographed. Ten of the latter class have been observed up to the present, and the authors propose to call these "ultra-violet" flowers. Photographs of some of these are reproduced. The yellow colouring material of the male flowers of *cucurbita pepo* was extracted by means of boiling alcohol, and on cooling the colouring material separated out. After filtration the material was found to dissolve very easily in benzol or ether. An attempt was made to photograph a layer of the material deposited on a sheet of paper by evaporation of the benzol solution, but the colour had disappeared in less than 45 minutes. Red and orange-yellow glass was found to hinder the decomposition of the material when exposed to the sun's rays. A. W.

445. *Quantum Theory.* **M. Wolfke.** (Deutsch. Phys. Gesell., Verh. 15 21. pp. 1128–1129, Nov. 15; 15. 22. pp. 1215–1218, Nov. 30, 1913, and 16. 1. pp. 4–6, Jan. 15, 1914.)—A discussion of the quantum theory on the basis of the supposition that not only in emission and in absorption, but also in free space, luminous energy has a discontinuous character. [See Abstract No. 1456 (1910).] E. H. B.

446. *A Case of Abnormal Trichromatic Colour Vision due to a Shift in the Spectrum of the Green-sensation Curve.* **W. de W. Abney** and **W. Watson.** (Roy. Soc., Proc. Ser. A. 89. pp. 232–245, Sept. 22, 1913.)

447. *Theory of the Cornu Photopolarimeter.* **G. Dimmer.** (Akad. Wiss. Wien, Ber. 122. 2a. pp. 913–932, May, 1913.)

448. *On the Bravais-Zakrzewski Elliptic Analyser.* **E. Perucca.** (N. Cimento, 6. Ser. 6. pp. 179–198, Sept., 1913.)—Discusses the applications of the analyser and also certain errors. L. H. W.

449. *Sulphides in the Infra-red.* **I. B. Crandall.** (Phys. Rev. 2. Ser. 2. pp. 343–362, Nov., 1913.)—The author has determined the percentage of infrared radiation reflected from and transmitted by several specimens of molybdenite, stibnite, and sphalerite, using a balanced method instead of a deflection method with the bolometer. He has calculated the extinction coefficients, and for molybdenite and stibnite also the refractive indices and conductivities. J. M.

450. *Absorption of Ultra-violet Light by Bromine Vapour.* **G. Ribaud.** (Comptes Rendus, 157. pp. 1065–1068, Dec. 1, 1913.)—The electromagnetic theory of absorption gives for the values of the index of extinction χ the formula $\chi = gg'\lambda^3/2[(\lambda^2 - \lambda_m^2)^2 + g'^2\lambda^2]$. In the case of gases a kinetic theory of absorption developed by Lorentz, then by Bloch, gives for the damping coefficient g' the relation $g' = \lambda_m^2/\pi v t$, t denoting the duration of the mean free path of the gas molecules and v the velocity of light. Lorentz and Königsberger on the one hand, and Bloch on the other, in their attempts at verification, have come to different conclusions. The present paper describes quantitative measurements of the absorption by bromine vapour in the ultraviolet. Bromine vapour has a spectrum of absorption bands easily resolvable into fine lines, extending from λ5000 to the extreme red, and also a continuous region of absorption between about λ5200 and λ3400. The present measurements were made in the latter region. A photographic method of determining the ratio of incident (I_0) and emergent (I) intensities is described. Hence χ is found from $I/I_0 = e^{-2\pi\chi d/\lambda}$, where d is the thickness of gas traversed. Measurements in Br-vapour alone, made at a pressure of 66 mm., give $\lambda_m = 4200$ and $\chi_m = 9{\cdot}1 \times 10^{-6}$; hence g' can be calculated from the relation $\chi/\chi_m = g'^2\lambda^3/\left\{\lambda_m[(\lambda^2 - \lambda_m^2)^2 + g'^2\lambda^2]\right\}$. g' varies considerably along the absorption curve; and the numbers thus found give for t values of the order of 10^{-15}, which, of course, do not agree with the kinetic theory. A second series of measurements made at pressures of from 1 to 15 cm. has shown that for each value of λ, χ is proportional to the pressure, and that, in consequence g' is constant when the pressure of the vapour itself varies. Dufour has

pointed out that, for the fine absorption lines of Br, g' increases very rapidly if to the vapour is added non-absorbing gas at high pressure. Measurements made with CO_2 at 56 atmos. and with oxygen at 115 atmos. have shown that in the case of the large absorption band g' is not modified. There is simply a diminution of 1/20 in the value of χ_m, which can easily be explained on the electromagnetic theory. Hence the kinetic theory of absorption is at fault when large bands are in question, though for fine lines it appears to account for the observed facts. A. W.

451. *Investigation of Arc Light with Spectroheliograph.* **O. Oldenberg.** (Zeitschr. wiss. Phot. 13. pp. 133–172, Dec., 1913.)—An apparatus was constructed on the principle of the spectroheliograph, which allowed monochromatic images of an arc light to be obtained. The apparatus was used to investigate the steady-current arc light. Consideration of the Na lines gave the following results:—The principal series and the second subordinate series are emitted principally by the outer portion of the arc flame, the first subordinate series by the inner portion. The fact that the principal series and the second subordinate series are found together throws a new light on the relation between the two already known from the formulæ for spectral series and from observations of the Zeeman-effect. Lines of Al, Mg, Ca, Li, Hg, Cu, Fe, Ba, Si were also investigated. In the investigation of bands two types of image were observed. In the first type, which are furnished by all the carbon and cyanogen bands, the core of the arc light is uniformly bright, while at the edges the brightness gradually diminishes. An altogether different type is given by other bands; in this the edges of the arc are decidedly brighter than the core. Both types show characteristic differences from the arc images furnished by lines. Thus the monochromatic image of the arc may be used as a criterion to determine whether the emission is that of a line or band. The spectrum of the arc-light core was also investigated through a narrow cylindrical hole down the centre of the positive carbon, so that the spectrum of the outer sheath was eliminated. It was found when the conditions are so chosen that the bands of the first type (carbon and cyanogen) appear much brighter in the core than in the outer sheath, that all metal lines, as well as bands of the second type, are, on the other hand, much darker in the core than in the outer sheath. A. W.

452. *Arc and Spark Lines with the Tube-arc.* **A. S. King.** (Astrophys. Journ. 38. pp. 315–340, Nov., 1913. Contribution from the Mt. Wilson Observatory, No. 73.)—Experiments have been continued with the tube-arc [see Abstract No. 1655 (1913)] in which a graphite tube in an electric furnace is arranged to break down at a certain section, thereby forming an arc surrounded by vapour at a very high temperature. Under these conditions it is found that lines specially characteristic of the spark spectrum are obtained. Photographs are reproduced showing the variations of spectrum in different parts of the tube, and the different behaviour of certain elements under similar conditions. Tests are also described in connection with the ionisation of the vapour, and on its conductivity compared to that of the tube material. The results of these indicate that the effects may be largely due to the impact of electrons emitted by the highly heated carbon, the resultant effect of these impacts becoming stronger near the centre of the tube. C. P. B.

453. *Reflection Spectra of Praseodymium Compounds.* **P. Joye.** (Archives des Sciences, 36. pp. 431–438, Nov., 1913.)—Investigations similar to those previously made on neodymium salts [see Abstract No. 1951 (1913)] have been carried out with praseodymium oxide, hydroxide, chloride, sulphide, sulphate, nitrate (+ $6H_2O$) and oxalate (+ $10H_2O$). The reflection spectra are characterised by lines or groups of lines for values of λ between 5000 and 4400 Å., and between 5900 and 5700 Å. The loss of water in passing from the hydroxide to the oxide displaces the spectrum towards the red, and the spectra of the sulphide and chloride are also extended in the direction of the red. With compounds containing an acid radical, the whole of the spectrum is displaced towards the violet. As with neodymium salts, so also with those of praseodymium, the function of the compound plays a more important part in the reflection spectrum than does the metal itself. T. H. P.

454. *Quantitative Study of Absorption Spectra by the Radiomicrometer.* **J. S. Guy** and **H. C. Jones**. (Amer. Chem. Journ. 50. pp. 257–303, Nov., 1913.)—In general, the more concentrated the solution of a salt the less the transparency and the broader the absorption band. Aqueous solutions of hydrated salts are often more transparent than pure water; this is attributed to the effect of the dissolved substance on the absorption spectra of water; the combined water seems to have less power to absorb light than free or uncombined water. T. M. L.

455. *Energy-emission from the Atom in Spectral Lines.* **H. Zahn.** (Deutsch. Phys. Gesell., Verh. 15. 22. pp. 1203–1214, Nov. 30, 1913.)—Wiedemann has calculated the energy emitted per sec. in the D-line region by a sodium atom in a Bunsen flame fed with salt. He found that 1 gm. of Na under such conditions would emit 3210 gm.-cals. per sec. Taking the weight of the H atom as $1{\cdot}63 \times 10^{-24}$ gm., the Na atom in the flame would then emit $5{\cdot}06 \times 10^{-12}$ erg per sec. Calculations made now by the author give very different results to those of Wiedemann. He finds that each atom gives out $7{\cdot}01 \times 10^{-9}$ erg per sec., corresponding to the emission by 1 gm. of Na of $4{\cdot}47 \times 10^{6}$ gm.-cals. per sec.—values which are roughly 1000 times Wiedemann's values. A. W.

456. *Quantum Theory and Infra-red Absorption Spectrum of Water-vapour.* **A. Eucken.** (Deutsch. Phys. Gesell., Verh. 15. 21. pp. 1159–1162, Nov. 15, 1913.)—On the old form of the quantum hypothesis the following expression was derived for the frequency of a molecule: $\nu = nh/(2\pi)^2 J$, in which J is its moment of inertia and n is an integer. This equation was applied by N. Bjerrum in 1912 to the data then available for the infra-red absorption spectrum of water-vapour. Since then further work has been done by H. Rubens and E. v. Bahr, and the present author now compares this equation with the present more extended experimental knowledge. The agreement is satisfactory and affords unequivocal evidence for a *discontinuous distribution of energy* and against the newer conception of Planck as to the energy being continuous and only the number of molecules in a specified energy region changing discontinuously. [See Abstract No. 1178 (1911).] E. H. B.

457. *Series of Lines in the Spectrum of Neon.* **R. Rossi.** (Phil. Mag. 26. pp. 981–984, Dec., 1913.)—Runge and Paschen found that the line spectrum of helium can be grouped into six series, viz., two sets of a principal with its two subordinate series. Watson [Abstract No. 1127 (1911)] failed to find any series in the Ne spectrum, though he found several groups of lines repeating themselves with constant frequency-difference. The present author has found three series of lines in the Ne spectrum: two series of doublets with constant frequency-difference and common convergence frequency in the visible spectrum, and one series of single lines in the ultra-violet. These series lines are rather weak compared to the lines forming the constant frequency-difference groups, which probably accounts for their being overlooked by Watson. In the tables given the wave-lengths are from Watson's paper [see Abstract No. 1794 (1908)], and, since the lines in series are not numerous, Rydberg's formula was adopted since Kayser's and Hicks' modifications of Ritz's formulæ, although giving better agreement between calculated and observed values, have the disadvantage of requiring one more constant. The two series with a common limit at λ4119·8 resemble two subordinate series, but all efforts to find the principal, which might be expected to accompany them, have so far failed. They appear not to correspond with any of the helium subordinate series, for although nearer to the red end of the spectrum the approximate relation between the separation of doublets and the square of the atomic weights does not hold. H. H. Ho.

458. *Origin of Series Spectra.* **A. W. Conway.** (Phil. Mag. 26. pp. 1010–1017, Dec., 1913.)—An attempt is here made to picture a model of an atom based on the classical electrodynamics, which will illustrate some of the properties of spectral series. The principal difficulties in explaining a frequency formula of the type $\nu = \mathrm{A} - \mathrm{B}/(n + \mu)^2$, where $n = 1, 2, 3 \ldots$, are three: (i) the formula gives the frequency and not the square of the frequency; (ii) no elastic or electrical system has a frequency equation of this type, the frequency increases as n increases and becomes infinite with n; (iii) the amount of radiation given out must obey Planck's law. As regards (i), as pointed out by Rayleigh, the difficulty can be overcome by making the frequency depend on the *magnetic* force; and as to (ii) this paper is intended to point out a mode of connection between the vibrations of elastic bodies and the above law. The question of energy radiated according to Planck's law is dealt with in the last section, where it is shown that the kinetic energy radiated is homogeneous and of amount $h\nu$, where h is a constant having the value $6{\cdot}8 \times 10^{-27}$ (Planck's constant being $6{\cdot}5 \times 10^{-27}$). The atom considered is a "Thomson" atom rotating with a constant angular velocity. It is shown that all single negative electrons having circular orbits in such atoms have a constant angular momentum h/π. If the atom is supposed capable of executing elastic vibrations, reasons are given for supposing that the innermost nodal sphere in any mode will capture the electron. A frequency formula of the type $\nu = \mathrm{A} - \mathrm{B}/(n + \mu)^2$ is arrived at, A depending on the *external* structure of the atom, B being the same for all atoms, and μ depending on the nature of the surface conditions for the elastic waves. The simplest form of atom—the sphere—and the simplest mode of vibration—the radial—are considered. It is possible that more complex conditions will give better results. A. W.

459. *Influence of the Size of the Particles on the Electro- and Magneto-optic Properties of a Liquid Mixture.* **A. Cotton, H. Mouton,** and **P. Drapier.** (Comptes Rendus, 157. pp. 1519–1522, Dec. 29, 1913.)—In a previous paper [see Abstract No. 215 (1914)] the authors have dealt with the optic properties of a liquid mixture submitted to the simultaneous action of a magnetic and an electric field. In a theoretical discussion of the subject [Le Radium, 10. p. 152, May, 1913] Pockels concluded that the method the authors proposed to use ought to succeed in the case of liquid mixtures containing relatively large particles, but that the results should be less and less sharp as the particles become smaller, and that the method should be inapplicable (with the means employed) in the case of the molecules of the pure liquids themselves. Experiments were undertaken to see if Pockels' conclusions were justified, using mixtures of calcium benzoate and aniline. The crystalline powder was stirred into the liquid, and after allowing more or less time for the particles to settle, the upper liquid was decanted and used in the experiments. The magnetic field alone gave a means of classifying the liquids according to the size of the particles, the magnetic double refraction tending more or less rapidly to a "saturation" value. This saturation value is much more quickly reached with mixtures containing large particles, for which the Brownian movements have relatively less importance. Repeating the experiments (previously described) relative to the superposition of the two fields, it was found that the departures from the additive law noted before are correspondingly more noticeable as the particles are larger. Thus Pockels' conclusions are verified in the sense that the effects sought for are sharper with more intense fields, and with the fields used, as the particles are larger. But the experiments also show that results can be obtained when the saturation has not been reached for either of the fields employed. It appears to be necessary to increase considerably the values of the fields used, and also to test the validity of Pockels' conclusions for pure liquids. A. W.

460. *Effect of Electric Field on Spectrum Lines.* **E. Warburg.** (Deutsch. Phys. Gesell., Verh. 15. 23. pp. 1259–1266, Dec. 15, 1913.)—It is here shown that Bohr's theory applied to Rutherford's model atom will explain to a certain degree of accuracy the effect of magnetic and electric fields on spectrum lines. Quantitative results are, however, so far from being in agreement with the observations of Stark [see Abstract No. 288 (1914)] that modification or amplification of the theory is necessary. In view of this discrepancy between the observed values and those calculated from the theory, it appears worthy of notice that according to the theory the electric effect is proportional to Planck's action-quantum *h*, while the magnetic effect is independent of *h*. A. W.

461. *Arc Spectrum of Nickel in International Units.* **S. Hamm.** (Zeitschr. wiss. Phot. 13. pp. 105–130, Dec., 1913. Extract from Dissertation, Bonn.)—Earlier measurements of the lines in the spectrum of nickel are briefly dealt with. In the present research, pure Ni rods 1 cm. diam. were used in the direct-current arc, the current being 6 to 7 amps. For photographing the spectrum a Rowland concave grating was employed, with 20,000 lines to the inch and a radius of 6·84 m. The dispersion was such that in the second order 1 mm. of the photographic plate corresponded to 1 Å. Wave-length tables, in international units, are given of many hundred lines, ranging from λ7122·276 to λ2165·502, the results of Exner and Haschek and of Hasselberg being included for comparison. A. W.

462. *Electrodeless Spectra of Hydrogen.* **I. Masson.** (Nature, 92. p. 508, Jan. 1, 1914.)—While making experiments on the apparent production of neon and helium during electric discharges, the author noticed an effect which does not seem to have been previously observed. A powerful oscillatory discharge is produced in eight or nine coils of wire from two Leyden jars, with a spark-gap of about 2 in. in parallel, connected to a large coil which is run from the main supply. Set in the coils of wire is a glass bulb of about 800 cm.³ capacity, provided below with a small bulb containing coconut

charcoal, and connected by a side-tube and tap with a mercury pump. After evacuating, heating, and "washing out" the bulb with hydrogen, when pure hydrogen is admitted at a fairly low pressure and the discharge is passed, the glow is bluish in colour, and shows both hydrogen and mercury spectra; but if the charcoal bulb be cooled in liquid air so that mercury-vapour and any other impurities are removed, the glow is of a brilliant rose-colour, and shows only hydrogen lines. If the pressure is reduced, however, to a value somewhere below 1 mm., there appears in the middle of the rose ring a fairly bright blue zone; and whereas the former shows both the simple and complex spectra of hydrogen, the blue zone shows nothing but the elementary line-spectrum; and, moreover, the blue line λ4861 is more intense than the red line. Further reduction of pressure causes the obliteration of the blue zone by the spreading inwards of the rose ring. A. W.

463. *Ultra-red Absorption of Gases.* **E[va] v. Bahr.** (Deutsch. Phys. Gesell., Verh. 15. 21. pp. 1150–1158, Nov. 15, 1913.)—It has previously been shown [see Abstract No. 1946 (1913)] that the Bjerrum conception of the ultra-red absorption spectra of gases is in many respects in good agreement with the experimental results. By an indirect method it was also shown that the double bands are made up of many narrow bands. The research has been continued with HCl and CO_2. Using a quartz prism the absorption bands of HCl at 3·5 μ and of CO_2 at 2·7 μ were investigated; a considerably greater resolution of the bands was obtained than in earlier work. Curves are reproduced showing that in the HCl band there are 12 maxima, and from the positions of these maxima the rotation frequency of the molecule was calculated according to Bjerrum's theory. The absorption of CO_2 at 2·7 μ consists of two different absorption bands, which may probably be resolved into a double band when a slightly greater dispersion than that employed is used. A. W.

464. *Band Spectrum of Aluminium.* **A. de Gramont.** (Comptes Rendus, 157. pp. 1364–1368, Dec. 22, 1913.)—Observations were made of the spectra obtained by introducing metallic Al and various Al compounds into the high-temperature oxy-acetylene flame. In addition to the five bands already known, a sixth was found, more refrangible than the others. The wave-lengths of the heads of the secondary bands in this new band, which is much weaker than the other five, are: 4330·5, 4351·7, 4373·6, 4394·4, 4413·3, 4431·0, 4447·6, 4462·6. All the bands are degraded, like the others, towards the red, and the first head is not the most intense. A large number of minerals investigated exhibited the Al band spectrum. (*Erratum*, Ibid. 158. p. 79, Jan. 5, 1914.) A. W.

465. *Spectroscopy of Flames.* **A. Reis.** (Deutsch. Phys. Gesell., Verh. 15. 23. pp. 1247–1258, Dec. 15, 1913.—Describes an investigation of the different spectra arising in the following flames:—Ammonia-oxygen, cyanogen-oxygen, cyanogen-air, acetylene-oxygen, hydrogen-oxygen, hydrogen-air, coal-gas-air. A mixed jet was used in each case. A. W.

466. *Kathode Spectrum of Helium.* **P. G. Nutting.** (Nature, 92. p. 401, Dec. 4, 1913.)—Various articles have recently appeared dealing with a spectrum frequently associated with the spectrum of He and by some attributed to impurities in the He. If a helium tube be prepared with *disc*

electrodes, carefully freed from impurities, and operated on a transformer or continuous current (*not* on an induction-coil discharge), the region about the kathode will be filled with a bright pink glow. The spectrum of this kathode glow is the spectrum in question. If care be taken to avoid stray light from the anode column, it may be obtained quite free from the ordinary (anode) spectrum of He. When the disruptive discharge from an induction coil is used to excite the tube, or the tube is viewed end-on through a cylindrical electrode, the two spectra appear mixed in various proportions. In the author's work on the helium tube as a primary light-standard, scores of tubes were prepared and operated as above described. It was noted that the kathode glow was pale and greyish, until the last traces of impurities had disappeared, when it turned to a bright pink. In fact, the appearance of the pink kathode glow is an infallible criterion for the purity of the He, a spectroscope being unnecessary. Most gases exhibit two, and a few three quite distinct spectra: the anode (primary) and kathode spectra, and the secondary spectrum obtained with a disruptive discharge. Nitrogen is an example of a gas having all three spectra. Helium is one of the few gases and vapours the primary and secondary spectra of which are alike, but the anode and kathode spectra of which are quite different. A. W.

467. *High-frequency Spectra of the Elements.* **H. G. J. Moseley.** (Phil. Mag. 26. pp. 1024–1034, Dec., 1913.)—In the absence of any available method of spectrum analysis, the characteristic types of Röntgen radiation, which an atom emits when suitably excited, have hitherto been described in terms of their absorption in Al. The present paper contains a description of a method of photographing the high-frequency spectra, which makes the analysis of the Röntgen rays as simple as any other branch of spectroscopy. The author intends first to make a general survey of the principal types of high-frequency radiation and then to examine the spectra of a few elements in greater detail and with great accuracy. The results already obtained show that such data have an important bearing on the question of the internal structure of the atom, and strongly support the views of Rutherford and of Bohr [see Abstracts Nos. 1930 (1913) and 15 (1914)]. Kaye has shown that an element excited by a stream of sufficiently rapid kathode rays emits its characteristic Röntgen radiation. He used as targets a number of substances mounted on a truck inside an exhausted tube, a magnetic device enabling each target to be brought in turn into the line of fire. The apparatus was modified to suit the present work. The kathode stream was concentrated on to a small area of the target, and a Pt plate furnished with a fine vertical slit was placed immediately in front of the part bombarded. The tube was exhausted by a Gaede pump, charcoal in liquid air being also sometimes used to remove water-vapour. The Röntgen rays, after passing through the slit, emerged through an Al window 0·02 mm. thick. The rest of the radiation was shut off by a lead box which surrounded the tube. The rays fell on a cleavage face of a crystal of potassium ferrocyanide which was mounted on the prism-table of a spectrometer. A photographic plate was mounted on the spectrometer arm, and both the plate and slit, S, were 17 cm. from the axis. If P is the part of the crystal where the radiation strikes the surface and L the line on the photographic plate corresponding to radiation of definite frequency with glancing angle of incidence θ, then $2\theta = 180° - \mathrm{SPL} = 180° - \mathrm{SAL}$, A being the position of the axis of the spectrometer table. A method is given for determining the angle SAL. Hence θ is known. The following elements were examined: Pt, Ta, Ca, Ti, V, Cr, Mn, Fe, Co, Ni, Cu,

and Zn. It is seen from the photographs that the spectrum of each element consists of two lines. Of these the stronger has been called a and the weaker β. The lines found on any of the plates besides a and β were most probably all due to impurities. No other lines have been found; but a search over a wide range of wave-lengths has been made only for one or two elements, and perhaps prolonged exposures, which have not yet been attempted, will show more complex spectra. The prevalence of lines due to impurities suggests that this may prove a powerful method of chemical analysis. Its advantage over ordinary spectroscopic methods lies in the simplicity of the spectra and the impossibility of one substance masking the radiation from another. The similarity of the different spectra is shown by the fact that the two lines a and β remain approximately constant, not only in relative intensity, but also in relative wave-length. The frequency of β increases, however, slightly faster than that of a. The same two lines, a strong and β weak, constitute the rhodium spectrum examined by Bragg, and they are obviously in some way closely related. One or two photographs taken with the radiation from Pt gave results in good agreement with those obtained by the electrical method, but no trace of the elaborate system of bands described by de Broglie in the reflection from rock-salt was encountered. A discussion is given of the meaning of the wave-lengths found for the principal spectrum-line a. The discussion is based on Bohr's theory of atomic structure. A. W.

468. *Spectrum of Water-vapour in Magnetic Field.* **H. Deslandres** and **L. d'Azambuja.** (Comptes Rendus, 157. pp. 814–820, Nov. 10, 1913.)—Observations made on the spectrum of water-vapour with a spectrograph of moderate dispersion, and a Weiss electromagnet giving a field of 32,000 gauss in a gap of about 2 mm., showed that while there was no sign of doubling of the rays, there was a decided displacement of all the lines. Detailed examination of the amounts of shift for various lines enables a selection into series to be made which may prove useful in cases of very complex spectra. C. P. B.

469. *Energy-distribution in Emission Spectra of Phosphorescent Compounds.* **P. Borissow.** (Ann. d. Physik, 42. 6. pp. 1321–1358, Dec. 23, 1913.)—From the researches here described it appears that the energy-distribution for each single phosphorescence band in the spectrum can be represented by a probability formula. A method is given by which the complete resolution of the phosphorescence spectrum into single bands may be accomplished. This resolution was effected completely for the first time with CaBi and SrBi. The analogies between the Bi bands in Ca and Sr are established for four bands and are considered in detail. The wave-lengths of the emission maxima of the a- and β-bands are always greater with increased temperature, though at the lowest temperatures they are at first smaller for the a-bands; they can for the higher temperatures be represented as a linear function of the temperature. For the β_1-bands the wave-lengths of the emission maxima show no dependence on the temperature. The principal (a-) bands of CaBi- and SrBi-phosphore are broader at higher temperatures, as Lenard has previously found for most bands. [See also Abstracts Nos. 726 (1905) and 810 (1910).] A. W.

470. *Phosphorescence of Mercury-vapour.* **F. S. Phillips.** (Nature, 92. p. 401, Dec. 4, 1913.)—The author has previously given an account of a persistent fluorescence of mercury-vapour produced by excitation with λ2536 light, obtained from a quartz mercury lamp [see Abstract No. 1827 (1913)].

When the fluorescent vapour is placed in a strong magnetic field, the mercury lamp being cooled so that the line λ2536 is sharp, the field increases the intensity of the fluorescence several times. If the lamp is allowed to warm up so that the λ2536 line becomes broadened and reversed, the opposite effect is obtained, *i.e.* the fluorescence decreases in intensity with the field. In this latter case the field strength that produces the greatest diminution in intensity increases with the temperature of the lamp. The ordinary fluorescence produced by the light from the Cd spark is not affected by the magnetic field. Further work is in progress with a view to obtaining a satisfactory explanation of the persistent fluorescence and the various phenomena connected with it. A. W.

471. *Effect of Magnetic Field on Intensity of Fluorescence.* **W. Steubing.** (Deutsch. Phys. Gesell., Verh. 15. 22. pp. 1181–1186, Nov. 30, 1913.)—The author finds that a magnetic field causes a 85 % loss of intensity in the fluorescence produced in iodine vapour by white light: all the lines lose equally in intensity. Also the resonance spectra show the same effect. No effect was noticed with mercury, selenium, sodium, tellurium, or anthracene vapour. A corresponding absorption effect in iodine could not be detected. J. M.

472. *Colour Photography of Luminescence.* **J. M. Lohr.** (Journ. Phys. Chem. 17. pp. 675–681, Nov., 1913.)—Details are given respecting the successful use of colour-photography to determine the quality of the visible light emitted during kathode luminescence and also the quality of light emitted by the flames of various substances. It is found that the Dufay plates are not particularly sensitive to the very faint kathodoluminescence of some of the halogen salts, while in the use of the Dufay colour plates for lantern-slides the intense heat and light of the lantern place a limitation on the length of time that the slide should be left in the lantern. A. E. G.

473. *Luminescence.* **E. F. Farnau.** (Journ. Phys. Chem. 17. pp. 637–656, Nov., 1913.)—The author has examined the luminescence produced in the halogen salts and, in some cases, the carbonates and sulphates of Na, K, Li, Rb, Cs, Cd, Zn, and Hg by kathode rays, canal rays, ultra-violet light, heating after excitation, trituration, and chemical action. The conclusion is drawn that luminescence in all its forms is due to chemical action, increase of the rate of reaction by rise of temperature or by addition of a catalytic agent increasing the luminescence. The quality of the luminescence is but slightly altered either by change of temperature or by the nature of the catalytic agent. The nature of the luminescence generally depends almost entirely on the kathion, although in a few cases a specific effect of the anion is observed. The quality of the luminescence is independent of the mode of production, although in many instances it can be changed to an entirely different kind of light by particular modes of excitation, such as rapid chemical action or canal rays. The chemical reaction producing a given luminescence can in some cases be formulated. T. H. P.

474. *Zeeman-effect of H_α in Weak Magnetic Fields.* **P. Erochin.** (Ann. d. Physik, 42. 5. pp. 1054–1060, Dec. 2, 1913.)—Two Leyden jars about 40 cm. high and an inductance of 0·0045 henry were used with the hydrogen vacuum tube, which was operated on a transformer. With the above capacity and inductance the two components of H_α were almost completely separated in the absence of any field. The Zeeman-effect for the p-components of the

line H_α is such that the constituents of the doublet approach one another as the applied field becomes stronger, and for the highest fields used (14,500 gauss) appear to merge into a single line which is considerably broader than the single constituents. The displacement of the constituents towards one another appears to be proportional at first to the square of the field strength. With the *s*-components at first only a broadening of the constituents is noticeable, which soon merge into one another. From about 5000 gauss the beginning of the separation into a triplet is apparent, with the outer component on the red side the most intense. Various effects are noted as the field is increased to about 11,000 gauss. A. W.

475. *Atomic Models and Röntgen-ray Spectra.* **F. A. Lindemann.** (Nature, 92. pp. 500–501, Jan. 1, 1914.)—Moseley has recently described his measurements of the characteristic Röntgen-ray lines of various metals [see Abstract No. 467 (1914)]. He has calculated the wave-lengths of one-half of the lines he observed, assuming Bohr's atom and supposing the positive charge on the nucleus to correspond to the place of the element in the periodic table, as suggested by van den Broek. He concludes that the agreement between calculated and observed wave-lengths strongly supports the views of Rutherford and of Bohr. To Lindemann it appears that Moseley's research really only supports the views of Rutherford and of van den Broek. He proposes to show in detail in a subsequent paper that the relation between the wave-length and the positive charge may be obtained in a large number of different ways. For the present it may suffice to point out that it may be derived from a simple consideration of the dimensions of the quantities involved. The frequency ν can only be supposed to depend upon the magnitude of the positive and negative charges Ne and ne, upon the mass m of the moving charge, upon the distance r between the charges, and upon Planck's element of action h. As Nne^2, m, r, and h must be combined in such a way that the dimension of the resulting quantity is T^{-1} we have $(NnML^3T^{-2})^x M^y L^z (ML^2T^{-1})^u = T^{-1}$, whence $y = x - 1$, $z = x - 2$, and $u = 1 - 2x$. If $x = 0$ we find $\nu = \text{const.} \times h/mr^2$, the constant being of the order unity, as Einstein pointed out. Assuming the characteristic Röntgen rays to be due to the movement of a single electron, we must suppose r to be proportional to 1/N, where N corresponds to the number of free positive charges on the nucleus found by Rutherford and van den Broek. Roughly speaking, this would be the case if the repulsive force keeping the electrons away from the centre were proportional to $1/r^3$ as suggested by Thomson. If $x = 1/2$ we find $\nu = \text{const.} \times \sqrt{(nNe^2/mr^3)}$. This formula is interesting, as it does not contain h, and so may be derived from the ordinary laws of mechanics. It also reduces to Moseley's formula if $r \sim 1/N$. If $x = 1$, $\nu = \text{const.} \times nNe^2/hr$. If one electron is supposed to oscillate, r must again be assumed proportional to 1/N to fit the facts. If all $n = N$ electrons oscillate, r must be supposed to be constant. In this case the formula accounts also for the second series of lines which Moseley's formula fails to do. They may be calculated with great exactitude by putting $\nu = \text{const.} \times N(N - 1)e^2/hr$, which corresponds to an atom which has lost one electron. If we put $x = 2$, we find $\nu = \text{const.} \times n^2N^2e^4m/h^3$, which is obviously identical with Moseley's formula, if we suppose only one electron to oscillate. The agreement of Bohr's constant with experimental data does not appear to the author convincing in view of the large number of arbitrary assumptions in his derivation All the above formulæ are independent of the choice of any special model. They are selected so that the expression for ν is successively independent of e^2, h.

m, or *r*. They would seem to prove that Moseley's figures need not be taken to confirm Bohr's views on the constitution of the atom. The only essential assumption common to them all is that N should correspond to the place of the element in the periodic table approximately, as suggested by Rutherford and van den Broek, and it would seem therefore that this hypothesis only can be said to be supported by Moseley's experiments. A. W.

476. *Atomic Models and Röntgen-ray Spectra.* **N. Bohr and H. Moseley.** (Nature, 92. pp. 553–554, Jan. 15, 1914.)—Lindemann has recently [see preceding Abstract] dealt with the approximate agreement between Moseley's experiments and Bohr's theory. Bohr here criticises Lindemann's method of procedure, which he does not think is justified. He argues that just as little as the five quantities ν, r, Nne^2, m, and h, the four quantities r, Nne^2, m, and h may be considered as independent of each other. By a consideration of dimensions a relation can be obtained between these four quantities, and if this relation is introduced in Lindemann's expressions for ν, all the different expressions become identical. A consideration of dimensions only cannot give the numerical factors which determine the exact values for the frequencies of the spectrum of an element; for this, more detailed assumptions as to the constitution of the atom and the mechanism of the emission of radiation must be introduced. Moseley also criticises Lindemann's method, and advances reasons for the conclusion that his experiments support the hypothesis that h is a fundamental factor in the atom. He also states that he has not succeeded in obtaining agreement between his results and the vibrations considered by Nicholson. Two things suggest that either Bohr's theory, or Moseley's interpretation of it, requires modification. In the first place, it fails to account for the second weaker line in each spectrum. In the second place, it is difficult to see how a ring of four electrons can store up enough energy to vibrate as a whole. A. W.

477. *Atomic Models and Röntgen-ray Spectra.* **J. W. Nicholson.** (Nature, 92. pp. 583–584, Jan. 22, 1914.)—It is universally assumed that the atom of an element can form a Saturnian system with more than one ring of rotating electrons, and this idea is used in particular by Moseley in the theoretical discussion of his recent experiments [see Abstract No. 467 (1914)]. But it is shown in an Adams prize essay, not yet published in full, that this is impossible. If the law of repulsion between two electrons, or of attraction between electron and nucleus, is that of the inverse square, more than one *coplanar* ring cannot exist. All the electrons in any plane must lie in the same ring, and even if they are in different planes the radii of the rings must be nearly equal. A simple case is quoted in illustration. This conclusion not only belongs to any ordinary dynamical theory of the rings, but to Bohr's theory also; for Bohr supposes that the *steady rotation* of the system can be derived by ordinary mechanics, and, in fact, the equation so derived is vital to his formula for spectra. So if Bohr's theory is to remain, then the idea of concentric rings in the atom, with Röntgen radiation coming from an inner ring, must be abandoned. For any way of avoiding the present conclusion, for example, by making a change in the law of attraction in the immediate neighbourhood of the nucleus, at once destroys the formula on which Moseley bases his view that his experiments support Bohr's theory. It is shown that Röntgen radiation may be given out, according to Bohr's theory, by a single ring, without a serious reduction in its radius. In this case the calcium Röntgen-ray spectrum, for example, means exactly the same thing as

the ordinary hydrogen spectrum, and no element should show such Röntgen-ray spectra until N, the number of units in the nucleus, becomes large. The Röntgen-ray or Balmer spectrum of helium, for example, would have a principal line, $\lambda = 694{\cdot}5 \times 10^{-8}$, between the ultra-violet and Röntgen-ray regions. But there is a serious difficulty when the number of units in the nucleus is so much greater than n, the number of electrons. For Ca Moseley takes $N = 20$, $n = 4$. Possible explanations of this difficulty are suggested. Moseley states that he has not found a correspondence between the Röntgen-ray spectra and the vibrations of the element nebulium treated in one of Nicholson's papers. This is not to be expected, for the two investigations are unrelated. The simple-ring atoms used to interpret astrophysical spectra are supposed to have a *simple* nucleus, or to contain no α-particles, and to be incapable of giving series spectra. They are not identical with ordinary atoms, into which, however, they appear to change in the stars which follow nebulæ in order of evolution. A. W.

478. *Spectral Analysis of Röntgen Radiation by Means of Reflection and Heat Motion.* **P. Debye.** (Deutsch. Phys. Gesell., Verh. 15. 17. pp. 857–875, Sept. 15, 1913.)—This is a mathematical discussion of the fundamental hypothesis according to which the characteristic distribution of intensity of the interference and reflection images can be regarded as solely the consequence of the heat motion. The amplitude and intensity of the reflected monochromatic radiation for a given arrangement of the atom are first considered; then the mean observable intensity, and next the mean monochromatic distribution of intensity are discussed. Finally spectral analysis by reflection, and the deficiency of the proposed explanation and its cause are dealt with. [See Abstracts Nos. 604 and 1292 (1913).] J. J. S.

479. *Interference of X-rays.* **L. S. Ornstein.** (Phys. Zeitschr. 14. pp. 941–947, Oct. 1, 1913.)—Develops Bragg's theory of X-ray reflection [Abstracts Nos. 989 and 1778 (1913)] by a different mathematical method. Bragg's curve is explained, and brought into agreement with the intensity of the patches on Laue's photographs, by assuming that the incident radiation consists of a number of waves of different frequencies upon which a pulse with a thickness small in comparison with the wave-length is superposed. The ratio of these is of the same order as the number of effective surfaces. Laue's photographs give diffraction images of the order zero, from which no conclusions as regards wave-length can be drawn. Bragg's method of examining the intensity of reflected radiation at different angles of incidence yields values for the wave-length of the fluorescent radiation. Interesting conclusions can be drawn regarding the structure of crystals from both methods. E. E. F.

480. *Life of Uranium and Radium.* **S. Meyer.** (Akad. Wiss. Wien, Ber. 122. 2a. pp. 1085–1094, June, 1913.)—The fundamental data for the calculation of the average life of Ur are discussed. The ionisation current, produced by the α-particles from 1 gm. UrI + UrII, is found to be 1·87 e.s. unit, which is in agreement with McCoy and Ashman's value [see Abstract No. 154 (1909)]. Assuming ranges of 2·5 cm. and 2·9 cm. for α-rays from UrI and UrII, and the number of ions produced to be $1{\cdot}26 \times 10^5$ and $1{\cdot}87 \times 10^5$ respectively, then the following relation holds:—

$$i = 1{\cdot}87 = n(1{\cdot}26 + 1{\cdot}87)\,10^5 \times e,$$

where n is the number of α-particles given off per sec. by each Ur product.

If $e = 4{\cdot}65 \times 10^{-10}$ e.s. unit (Rutherford's value) then $n = 1{\cdot}12 \times 10^4$. If $e = 4{\cdot}78 \times 10^{-10}$ e.s. unit (Millikan's value) then $n = 1{\cdot}09 \times 10^4$. Hence, taking Rutherford's value for e, the number of α-particles emitted per sec. from UrI + UrII is $2{\cdot}24 \times 10^4$, whilst Rutherford and Geiger found it to be $2{\cdot}37 \times 10^4$. This slightly higher value found by Rutherford and Geiger is explained by the fact that possibly there might be a small quantity of ionium present in the preparation of Ur used—the presence of 10^{-5} gm. of Io-Th would account for the difference between the two values. The author, by using Ur salt freed from ionium found that $\lambda_{\mathrm{UrI}} = 4{\cdot}4 \times 10^{-18}\,(\mathrm{sec.})^{-1}$, $\tau = 7{\cdot}2 \times 10^{10}$ years, $T = 5{\cdot}0 \times 10^9$ years. Taking $3{\cdot}4 \times 10^{10}$ as the number of α-particles emitted per sec. from 1 gm. of Ra, the value $3{\cdot}2 \times 10^{-7}$ or $3{\cdot}3 \times 10^{-7}$ is obtained for the ratio Ra/Ur (when equilibrium exists), according as we take $e = 4{\cdot}78 \times 10^{-10}$ or $4{\cdot}65 \times 10^{-10}$.

By a second method based on the relation $\lambda_{\mathrm{UrI}} = \lambda_{\mathrm{Ra}} \times 238/226 \times \mathrm{Ra/Ur}$ another value of λ_{UrI} is calculated. From observations on the production of RaEm from ionium extending over a period of 4 years, the following data were deduced: $\lambda_{\mathrm{Ra}} = 1{\cdot}26 \times 10^{-11}\,(\mathrm{sec.})^{-1}$, $\tau_{\mathrm{Ra}} = 2500$ years, $T_{\mathrm{Ra}} = 1730$ years. Substituting the values of λ_{Ra} and Ra/Ur in the above equation we obtain the following mean values: $\lambda_{\mathrm{UrI}} = 4{\cdot}3 \times 10^{-18}\,(\mathrm{sec.})^{-1}$, $\tau_{\mathrm{UrI}} = 7{\cdot}37 \times 10^9$ years, $T_{\mathrm{UrI}} = 5{\cdot}1 \times 10^9$ years, which agree very closely with those obtained by the first method. It is found that the most consistent results are obtained if the following values be taken for the various quantities concerned:—

$$\lambda_{\mathrm{Ra}} = 1{\cdot}26 \times 10^{-11}\,(\mathrm{sec.})^{-1},\ n_{\mathrm{Ra}} = 3{\cdot}4 \times 10^{10},\ T_{\mathrm{Ra}} = 1730 \text{ years}$$
$$\lambda_{\mathrm{UrI}} = 4{\cdot}3 \times 10^{-18}\,(\mathrm{sec.})^{-1},\ n_{\mathrm{UrI}} = 1{\cdot}1 \times 10^4,\ T_{\mathrm{UrI}} = 5{\cdot}0 \times 10^9 \text{ years}$$
$$e = 4{\cdot}78 \times 10^{-10} \text{ e.s. unit.}$$

E. A. O.

481. *The Thorium Series.* **P. Beer** and **K. Fajans.** (Phys. Zeitschr. 14. pp. 947–951, Oct. 1, 1913.)—Evidence is brought forward in support of the scheme of Marsden and Darwin for the division of the thorium series at $\mathrm{ThC_1}$:

$$\mathrm{ThB} \longrightarrow \mathrm{ThC_1} \begin{array}{l} \nearrow \mathrm{ThD} \longrightarrow \\ \searrow \mathrm{ThC_2} \longrightarrow \end{array}$$

The version supported by L. Meitner, that there are two separable products of ThB, was probably suggested by the volatility of $\mathrm{ThC_1}$ chloride in presence of $\mathrm{SnCl_2}$. E. E. F.

482. *Parallelisms in Radio-active Transformations.* **K. Fajans.** (Phys. Zeitschr. 14. pp. 951–953, Oct. 1, 1913.)—In view of the behaviour of the thorium products [see preceding Abstract] it is probable that the branching of the three radio-active series does not take place at the B-terms, but at the $\mathrm{C_1}$-terms. The branching is due to the simultaneous emission of α- and β-particles. In the case of $\mathrm{RaC_1}$, the α emission is only made by three atoms in 10,000, in the case of $\mathrm{ThC_1}$ by 35 per cent. The life periods of the products appear to obey the general rule previously enunciated that the α-radiators of the same series decreases as the atomic weight falls, whereas the life period of the β-radiators increases. In the actinium series the ratio of atoms emitting α-particles to those emitting β-particles must at the branching point be even larger than in the Th series. This is a conclusion from the dependence of the stability of a product on its atomic weight. E. E. F.

483. *Reflection of Röntgen Rays.* **M. de Broglie, E. Jacot.** (Nature, 92. pp. 423–424, Dec. 11, 1913.)—M. de Broglie has recently described a new

method of investigating the reflection of Röntgen rays from a crystal [see Abstract No. 248 (1914)]. The present note gives a few further details. Up to the present only the doublet 11° 17′ and 11° 38′ described by Moseley and Darwin has been identified by the new method. The spectra contain also a number of bright lines about two octaves shorter than these, and the continuous spectrum is contained within about the same limits. These numbers may be used in interpretations of diffraction Röntgen patterns, as they were obtained with tubes of the same hardness as those used for producing these latter. The arrangement enables the spectra of different orders to be easily distinguished, as the interposition of an absorbing layer cuts out the soft rays, but does not weaken appreciably the hard rays of the second and higher orders. It is convenient also for absorption experiments; thus a piece of Pt-foil of 0·2 mm. thickness showed transparent bands. The exact measurements will be published shortly, together with the results of some experiments upon the effect of changing the temperature of the crystal. Experiments by **Jacot** seem to show that a regularly reflected beam of Röntgen rays on incidence at a second crystal surface again suffers optical reflection; but the degree of reflection is dependent on the orientation of this second reflector relative to the first. The second reflector is mounted on a suitably adapted goniometer, and the photographic plate is mounted immediately behind the crystal. The beam is a pencil 1·5 mm. in diam. When the two reflectors are parallel the impression on the plate, due to the two reflections, is clear. But as the second reflector is rotated about an axis given by the reflected beam from the first and fixed reflector the optically reflected radiation from the second reflector—other conditions remaining constant—diminishes very appreciably. As the angle between the reflectors is increased from 0° to 90°, the impression recorded on the photographic plate diminishes in intensity. For an angle of 20° it is still clear; for angles in the neighbourhood of 50° it is not always detectable; and for an angle of 90° it is very rarely detectable in the first stages of developing, and it is then so faint that it never appears on the finished print. These results, then, would show that the regularly reflected beam of Röntgen rays is appreciably polarised in a way exactly analogous to that of ordinary light. The selectively reflected Röntgen rays seem to show the same effects as does the regularly reflected beam. Selectively reflected radiation is always detectable after the second reflection, but this seems to be due to the selectively reflected radiation produced at the second reflector by the unpolarised portion of the beam regularly reflected at the first reflector. The application of a theory of polarisation to explain the above results is supported by the fact that in the case of two reflections by parallel reflectors, the proportion of Röntgen rays reflected at the second reflector is invariably greater than the proportion of rays reflected at the first. This might be expected if vibrations perpendicular to the plane of incidence are to be reflected to a greater extent than those in the plane of incidence. The proportion of such vibrations is larger in the beam incident on the second reflector than in the original beam, and a greater portion of radiation would be reflected at the second reflector than could be at the first. For the case of parallel reflectors and incidence of the primary beam on the first at the polarising angle, the reflection at the second should be complete. A. W.

484. *Tables of Exponential Functions relative to Radium Emanation.* L. **Kolowrat**. (Le Radium, 10. pp. 389–392, Dec., 1913.)—Five-figure tables are given of $\epsilon^{-\lambda t}$ and $(1-\epsilon^{-\lambda t})/\lambda$, the former representing the decay of radium emanation and the latter its growth when the production per hour is

taken as unity. The value taken for the disintegration constant λ is 0·00751 (hr.$^{-1}$) [see Abstracts Nos. 566 (1910) and 324 (1912)]. E. M.

485. *Variations of Ranges of Individual α-Particles.* **F. Friedmann.** (Akad. Wiss. Wien, Ber. 122. 2a. pp. 1269–1289, July, 1913.)—The author has made an experimental investigation of the decrease in the total number of α-particles which traverse a given distance from the source. In the case of polonium the falling-off of the number towards the end of the range is found to agree with the theoretical results of Herzfeld [Abstract No. 1587 (1912)] calculated from the probability variations in the number of molecules encountered in the paths of the individual α-particles. E. M.

486. *β-Rays of Radium Products.* **J. Danysz.** (Journ. de Physique, 3. Ser. 5. pp. 949–961, Dec., 1913.)—A collected account of the author's work on the velocities of the β-particles from Ra B, C, D, and E, together with that by Danysz and Duane on the total charge carried by the α- and β-particles of Ra (Em + A + B + C) [Abstracts Nos. 79 and 815 (1913)]. With regard to the diminution in the speed of β-particles in passing through matter, the experiments show that foils of either Al, Sn, Cu, Ag, or Au of the same mass per unit area produce the same decrease. For foils of weight 0·01 gm. per cm.^{2} the decrease in the value of Hρ (ρ = radius of curvature in field of strength H) varies from about 106 for a pencil of rays for which Hρ = 1500, to 42 for a pencil for which Hρ = 5300. E. M.

487. *Analysis of the γ-Rays of the Thorium and Actinium Products.* **E. Rutherford** and **H. Richardson.** (Phil. Mag. 26. pp. 937–948, Dec., 1913.)—In continuation of previous work [Abstracts Nos. 1675 (1913) and 94 (1914)] the primary γ-rays from the various radio-active products are found to be as follows:—

Element.	Atomic weight.	Absorption coefficient μ in Al.	Mass. Absorption Coefficient μ/d in Al.
Radium B	214	230 (cm.)$^{-1}$	85 (cm.)$^{-1}$
		40 „	14·7 „
		0·51 „	0·188 „
Radium C	214	0·115 „	0·0424 „
Radium D	210	45 „	16·5 „
		0·99 „	0·36 „
Radium E	210	similar types to D but very feeble.	
Mesothorium 2	228	26 (cm.)$^{-1}$	9·5 „
		0·116 „	0·0428* „
Thorium B	212	160 „	59 „
		32 „	11·8 „
		0·36 „	0·13 „
Thorium D	208	0·096 „	0·035 „
Radio-actinium	—	25 „	9·2 „
		0·190 „	0·070 „
Actinium B	—	120 „	44 „
		31 „	11·4 „
		0·45 „	0·165 „
Actinium D	—	0·198 „	0·073 „

[* Abstractor's correction.]

The rays may conveniently be divided into four types: (1) The soft radiations from the B-products which may vary from $\mu = 120$ to $\mu = 280$. (2) A more penetrating type from $\mu = 26$ to $\mu = 45$ probably corresponding to characteristic radiations of the L series. (3) A penetrating type from the B-products varying from $\mu = 0·36$ to $\mu = 0·51$. (4) A very penetrating type varying from $\mu = 0·115$ to $\mu = 0·198$, probably corresponding to characteristic radiations of the "K" series.

According to the views of Russell, Fajans, and Soddy [Abstract No. 170 (1914), etc.], the B-products of the three radio-active families are to be regarded as chemically identical, although they differ by about 2 units in their atomic weights. It would appear probable that this should also involve an identity in the electronic distribution and of the magnitude of the charge on the nucleus. If the γ-rays set up are due to the vibration of the electronic systems, it would be anticipated that the types of γ-rays emitted would be identical for such products. The experiments show that while there is undoubtedly close analogy between the γ-rays of the three B-products, yet the differences of penetrating power are well marked. By comparison of the penetrating powers of the γ-rays from corresponding products of the three series the authors deduce the atomic weight of Ac to be about 228, the general evidence indicating further that it is derived from Ur after the expulsion of two α-particles. E. M.

488. *Existence of Uranium Y.* **F. Soddy.** (Phil. Mag. 27. pp. 215–221, Jan., 1914.)—The author has confirmed the existence of Antonoff's UrY, the existence of which was recently questioned by Fleck [see Abstracts Nos. 1680 (1913) and 102 (1914)]. UrY appears "isotopic," or chemically non-separable from UrX_1. E. M.

489. *γ-Rays of Polonium, Radium, and Radio-actinium.* **A. S. Russell** and **J. Chadwick.** (Phil. Mag. 27. pp. 112–125, Jan., 1914.)—The experiments are in continuation of those described in Abstracts Nos. 481 and 1165 (1913), in which the presence was established of soft γ-rays accompanying the α-rays of various products. The chemical methods of separating pure polonium and radio-actinium are described. The results show that Po emits primary γ-rays of one type only with μ/D in $Al = 215\ cm^{-1}$. The α-rays of Po are able to excite a soft γ-radiation in Cu, probably the characteristic radiation in Series L. No appreciable γ-radiation is excited under similar circumstances in Pt or Pb.

Radium itself freed from its products is found to emit three types of γ-rays with values of μ/D in Al of 180, 6, and $0·1\ cm^{-1}$. The intensity of the γ-radiation of Ra itself is from 1 to 1½ per cent. of that of Ra in equilibrium with its short-lived products. The results show further that Radio-Ac emits two types of γ-rays, the values of μ/D in Al being 8 and 0·1. E. M.

490. *Delta Rays from Gases.* **N. Campbell.** (Phil. Mag. 27. pp. 83–91, Jan., 1914.)—In investigating the question of δ-radiation from gases by measurements of the current between two electrodes it must be considered that if the pressure is too great the electrons ejected in ionisation lose their initial velocities by collision with the molecules before they can make their presence felt at the electrodes. Again, if the electric field is too great the initial velocities of the electrons are inappreciable compared with those that they acquire in moving through the field. The author has therefore studied the question from observations of the current through a gas with a very small electric field and a pressure so low that collisions between the electrons liberated and the molecules of the gas are rare. An important factor which enters into the consideration is the affinity of the molecules of the gas for electrons—a question which has been studied by Franck and Hertz [Abstract No. 810 (1914)]. The author finally concludes that δ-rays are emitted from ionised molecules of gases with velocities of the same order of magnitude as those from metals. E. M.

491. *Measurements of Penetrating γ-Radiation from* 1000 *to* 4000 *Metres.* **V. F. Hess.** (Akad. Wiss. Wien, Ber. 122. 2a. pp. 1481–1486, July, 1913.)—The author has continued his observations [Abstracts Nos. 828 (1913), etc.] of the ionisation in a closed vessel during balloon ascents. The measurements show that above 2000 m. there is a fairly rapid increase in the ionisation, *i.e.* an increase in the penetrating γ-radiation. At this height the penetrating γ-rays from the earth itself are negligible, whilst those from any small amount of radium emanation in the air must be, at any rate, less than at the surface. The author thus concludes that a great part of the ordinary penetrating γ-radiation cannot come from the known radio-active constituents of the earth or atmosphere. E. M.

492. *Penetrating Radiation.* **K. Bergwitz.** (Phys. Zeitschr. 14. pp. 953–956, Oct. 1, 1913.)—Shows that the Wulf radiation-meter ("Strahler"), a string electrometer with two parallel threads, is subject to temperature and pressure in a manner which invalidates it for comparisons of ionisation currents at different times and places. The distortion of the case by varying atmospheric pressure is not serious except in the case of balloon ascents, but sunlight and warm air-currents have a very considerable action which it is difficult to eliminate. E. E. F.

493. *Measurements of the Earth's Penetrating Radiation with a Wulf Electrometer.* **J. C. McLennan** and **A. R. McLeod.** (Phil. Mag. 26. pp. 740–752, Oct., 1913.)—The experiments described are in continuation of those of McLennan [Abstract No. 617 (1913)]. The Wulf electrometer is, however, shown to be far more suitable than an electroscope for measurements in which steadiness of the instrument is not possible, *e.g.* on board a ship. The essential feature of the instrument is the use of two conducting quartz fibres attached at both ends instead of the usual gold-leaf. The distance apart of the fibres gives a measure of their potential. The results of the observations show that the number of ions produced per cm.^{3} in a closed zinc receiver is 4·3 on a vessel in the Atlantic and about the same when the receiver is immersed in water so that all penetrating radiation is cut off. This residual ionisation of about 4 ions per cm.^{3} must therefore either come from the walls of the zinc or from some very penetrating radiation not yet known, since it has been shown by J. J. Thomson and by Langevin and Rey [Abstract No. 1247 (1913)] that ionisation cannot be produced by ordinary collisions between molecules. However, Simpson and Wright, using a zinc receiver of 27 litres' capacity obtained 4 ions per cm.^{3} as the minimum ionisation, while the receiver used by the present authors had only 2 litres' capacity. The agreement between the results thus does not support the view that the residual ionisation is due to radiation from the walls of the receiver. E. M.

494. *Note on the Colour of Zircons and its Radio-active Origin.* **R. J. Strutt.** (Roy. Soc., Proc. Ser. A. 89. pp. 405–407, Jan., 1914.)

HEAT.

495. *Exposed Stem Correction for Mercury Thermometers.* **G. Dimmer.** (Akad. Wiss. Wien, Ber. **122. 2a.** pp. **1439–1460**, July, **1913.**)—The various formulæ and tables which have been used for correcting mercury thermometers for exposed stem are discussed, and in particular those of Rimbach which are quoted in Landolt and Börnstein's tables. Rimbach gives a series of formulæ for various temperature-ranges, but the author shows that the experimental results from which these formulæ are deduced can be adequately represented by the simple Kopp formula, $k = na(t_1 - t_2)$, where k is the correction, n the number of degrees exposed, a the apparent coefficient of expansion of the mercury, t_1 the temperature recorded by the thermometer, and t_2 that indicated by a thermometer whose bulb is at the centre of the exposed stem. Experiments are then described in which measurements of the correction are made with thermometers of Jena glass (N. 16) for the temperature-range −30° to +100° C., and with thermometers of borosilicate glass (N. 59) for the range 0° to 400° C. The author concludes that the tables given by Rimbach for thermometers of Jena glass are inaccurate; the results of his own experiments are given in tabular form, and are shown to be well represented by the formulæ $k = 0{\cdot}000156n(t_1 - t_2)$ and $k = 0{\cdot}000168n(t_1 - t_2)$ respectively. F. J. H.

496. *Thermal Conductivity of Mercury by the Impressed Velocity Method.* **H. R. Nettleton.** (Phys. Soc., Proc. **26.** pp. 28–40; Discussion, pp. 40–42, Dec., 1913.)—The paper gives an account of the determination of the thermal conductivity of mercury at room temperature by the method already described by the author [see Abstract No. 1112 (1910)]. The mercury is contained within a vacuum-jacketed siphon tube about 17 cm.^{2} in cross-section, which is heated at the top and maintained ice-cold at its lower extremity. The distribution of temperature down this tube is determined with the aid of a single thermo-junction, while the mercury is at the same time flowing uniformly up the tube at speeds ranging from 870 to 1420 gm. per 15 mins. The calorimetry is thus essentially continuous-flow calorimetry within the temperate gradient, the quantity of heat passing down the mercury being controlled and measured by the flow of liquid. The wires forming the thermo-elements—viz., iron and constantan—are contained within a vertical tube of 6 mm. diam. through the glass of which the wires are fused. This carrier tube is placed in the mercury column in such a way that the thermo-junction can be raised or lowered from outside by a cathetometer, or can be rotated in a horizontal plane to test the horizontality of the isothermals; these were found to be remarkably horizontal. Making use of the formula developed in the paper referred to [*loc. cit.*] the author obtains for the thermal conductivity of mercury at 15·5° C. the value 0·0201 in c.g.s. units. The advantages of the method lie in the simplicity of the calorimetry and in the fact that temperature ratios rather than temperature differences are required. F. J. H.

497. *Thermal Conductivity of Liquids.* **E. Hernqvist.** (Ark. för Mat. Astron. och Fysik, Stockholm, 8. No. 33. pp. 1–9, 1913.)—The thermal conductivities of hexane, heptane, and octane were determined by the flow of heat through a disc-shaped mass of liquid from one gilded copper-plate to a second copper-plate cooled with ice. The constant of the equation in one experiment varied only from 0·70 to 0·73 in ten successive readings, and five or six such series were used to determine the conductivity of each liquid. The resulting values in c.g.s. units were :—

Hexane	0·000364
Heptane	0·000337
Octane	0·000375

T. M. L.

498. *Use of Light-filters with the Holborn-Kurlbaum Pyrometer.* **M. v. Pirani.** (Deutsch. Phys. Gesell., Verh. 15. 17. pp. 826–833, Sept. 15, 1913.)—The action of the Holborn-Kurlbaum pyrometer is based on the comparison of the brightness of a luminous surface with that of a glow-lamp filament, the intrinsic brilliancy of the latter being modified until it appears identical with that of the surface studied. The instrument can thus be applied to quite small luminous objects. But in general it will not be possible to obtain exact resemblance in colour, which makes accurate comparison difficult. It has, therefore, been proposed to analyse the light from the sources studied, and to compare only the brightness in a small region of the spectrum. But spectro-photometric apparatus of this kind adds to the complexity of the instrument, and attempts have been made to use instead glass or gelatine colour-filters. The author describes a series of researches on the transparency and optical centre of gravity of four filters of this kind. He finds that the optical centre of gravity with varying temperature only alters as follows : 465–467, 537–542, 572–577, and 653–672 $\mu\mu$; these regions are so limited as to make the filters suitable for use with the pyrometer, but for temperature measurements the author prefers the two latter ones. The use of dark glasses as a means of diminishing the incident light was also investigated, and found to be satisfactory. J. S. D.

499. *Determination of the Relative Humidity of the Air by means of the Refractometer.* **F. Giraud.** (Journ. de Physique, 3. Ser. 5. pp. 900–902, Nov., 1913.)—Glycerine when exposed to the air has the property of absorbing a certain quantity of water-vapour, the amount of which depends upon the humidity of the air; variations in the strength of the solution of water in glycerine can easily be observed by means of a refractometer to determine the index of refraction of the liquid. As the index also varies with the temperature it is necessary to reduce all the observations to a constant temperature (20° C.). After this correction is applied the formula to calculate the relative humidity is found to be $H = 100\,(1 - a^x)$,

where $a = (n - 1{\cdot}333)/(1{\cdot}4747 - 1{\cdot}333) = (n - 1{\cdot}333)/0{\cdot}1417$.
Here n = index of refraction of the solution at 20° C.,
$x = n^{3\cdot086}$, and H = relative humidity.

The formula is found to hold for air of humidity varying between 50 and 94 per cent. It will be seen that, for saturation $n = 1{\cdot}333$, and for perfectly dry air n would be 1·4747, supposing the formula still to hold in that case.

In order to make an observation a cigarette paper is dipped in glycerine and placed upon the upper prism of the refractometer. A table calculated from the formula is given to avoid the necessity for computation, while the correction for temperature of the refractive index is also given. R. C.

500. *General Comparison of Vapour Pressures.* **J. M. Crafts.** (Comptes Rendus, 157. pp. 1403–1405, Dec. 22, 1913.)—A number of varied substances are found to obey the relation, $T - T' = (T''_a - T'''_a)C$, where T and T′ are the boiling-points of any particular substance and T''_a and T'''_a those of a standard substance at the pressures P and P′ respectively, while C is a constant independent of the temperature. As standard substance, naphthalene is chosen owing to its purity and stability. For various pressures ranging from 89 to 1741 mm., the above expression gives results in good accord with the observed values for nitrogen, oxygen, SO_2, CO_2, bromine, *n*-hexane, benzene, ethyl acetate, phenol, aniline, benzophenone, mercury and sulphur. The values of the expression 20C/T, where T represents the absolute boiling-point under 760 mm. pressure, are in all cases about 0·04. With hydrogen, chlorine, water, ethyl and isoamyl alcohols, and acetic and isobutyric acids, the above equation does not hold, but excellent agreement is given by $T - T' = (T''_a - T'''_a)[C \pm c(t' - t)]$. T. H. P.

501. *Vapour Pressures of Carbon Compounds.* **A. Schulze.** (Phys. Zeitschr. 14. pp. 922–926, Oct. 1, 1913.)—The vapour pressures were determined by a modification of Dumas' method. A large glass bulb had a small bulb attached to it by means of a capillary tube. After vaporising the substance under examination so as to fill both bulbs at atmospheric pressure, the bulb was sealed and the small bulb was plunged into liquid air, thus condensing all the vapour into the small bulb. The latter was then fused off and weighed, while the large bulb, now highly exhausted, was filled with water to determine its volume. The author gives a list of carbon compounds with their temperatures, vapour densities, and resulting molecular weights. The figures show that CS_2 contains complex molecules. Nitrobenzol is also associated in the state of vapour, as it is when liquid, but the alcohols, which form strongly associated liquids, are monomolecular as vapours. Ethyl ether, acetone, benzol, and hexane are also non-associated. E. E. F.

502. *Thermodynamics of Solids and Liquids.* **W. Nernst.** (Preuss. Akad. Wiss. Berlin, Ber. 52. pp. 972–985, 1913.)—A theoretical treatise on this subject dealing with the electrical, magnetic, and chemical properties as well as the thermal, elastic, and other physical properties. Special reference is made to low temperatures and the T^3 law for specific heats. E. H. B.

503. *Rotation Energy of Diatomic Gas on the Newer Quantum Hypothesis.* **E. Holm.** (Ann. d. Physik, 42. 6. pp. 1311–1320, Dec. 23, 1913.)—The newer formula given by Planck for the energy of a linear resonator is based on the assumption that the resonator can receive *all possible* quantities of energy, but that the resonators whose energies lie in the same *elementary region of energy*, *i.e.* all those whose energies lie between $(n - 1)h\nu$ and $nh\nu$ are *equally* distributed.

By an application of this modified quantum hypothesis is here derived the molecular energy of rotation for a diatomic gas which thus, contrary to the result of Ehrenfest, shows an unbroken increase of the molecular heat by rising temperatures. [See Abstract No. 691 (1913).] E. H. B.

504. *Relations between Dilatational and Thermodynamical Coefficients.* **T. Peczalski.** (Comptes Rendus, 157. pp. 584–586, Oct. 13, 1913.)—Utilising the characteristic differential equation, $dt = dv/v\alpha + dp/p\beta$, where α, β, p, v, and t have the usual meanings, the author deduces expressions for a small quantity of heat, dQ, and uses them to obtain the three adiabatic equations,

$$t-t_0=\frac{C-c}{C\beta}\log(p/p_0)=\frac{C-c}{c\alpha}\log(v/v_0),\ pv^{\frac{C}{c}\frac{\beta}{\alpha}}=\text{const.},$$

which apply in all cases where α, β, C, and c do not vary with p, v, and t; C and c are the specific heats at constant pressure and constant volume respectively. From an expression for the velocity of sound, viz. $V=\sqrt{C/c\,.\,\beta/\alpha\,.\,p/\rho}$, similarly developed the values of C/c for water and ether at atmospheric pressure and temperature are calculated. (*Erratum*, Ibid. p. 311, Nov. 3, 1913.) F. J. H.

505. *Boltzmann's Principle of Entropy and Probability.* **K. F. Herzfeld.** (Akad. Wiss. Wien, Ber. 122. 2a. pp. 1553–1561, July, 1913.)—A mathematical discussion of the equation embodying Boltzmann's principle, viz., $S=k\log W$. [See Abstract No. 315 (1911).] E. H. B.

506. *On Thermodynamics.* **K. v. Wesendonk.** (Deutsch. Phys. Gesell., Verh. 15. 17. pp. 839–856, Sept. 15, 1913.)—A theoretical discussion dealing with the views of Nernst, Wegscheider, and others; unsuitable for abstracting.

507. *Radiation of Gases.* **L. Zehnder** (Deutsch. Phys. Gesell., Verh. 15. 24. pp. 1317–1332, Dec. 30, 1913.)—A descriptive survey of modern views. [See Abstract No. 1076 (1912).] E. H. B.

508. *The Constant in the Radiation Law.* **E. Bauer.** (Journ. de Physique, 3. Ser. 5. pp. 641–649, Aug., 1913.)—Remarks on the work of J. de Boissoudy [Abstract No. 1307 (1913)].

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

509. *Quantities of Electricity Smaller than the Electronic Charge.* **F. Ehrenhaft.** (Deutsch. Phys. Gesell., Verh. 15. 22. pp. 1187–1202, Nov. 30, and 24. pp. 1350–1352, Dec. 30, 1913.)—By the observation of ultramicroscopic particles and the measurement of their charge and mass the author concludes that the electronic charge is not Nature's unit of electricity. It is here suggested that an electron may be a stable arrangement of yet smaller constituents, *sub-electrons.* Repeatedly in the experiments there appear charges which are of the order of *three-quarters*, the *half*, and the *quarter* of the electronic charge $4{\cdot}8 \times 10^{-10}$ e.s. unit. The experiments include observations on mercury particles in CO_2 and in nitrogen. E. H. B.

510. *Dielectric and Unipolar Induction.* **K. Fehrle.** (Ann. d. Physik, 42. 6. pp. 1109–1128, Dec. 23, 1913.)—An experimental research from which the following conclusions are drawn. Suppose an earthed cylinder carried by a metal disc to be concentrically placed inside another metal cylinder carrying a coil through which a current circulates, then—(1) If the outer cylinder rotates, it receives a charge provided the inner air does not rotate with it. (2) If the inner air rotates with it, it receives no charge. (3) The charge in case 1 is not dependent on the inhomogeneity of the field, but simply on the flux through the cross-section of the coil cylinder. (4) If the coil is rotated at the same speed in the opposite sense, the inner cylinder acquires a charge of the same sign as is developed by turning the inner cylinder, but the numerical value is different. Relativity between the motions of the cylinder and the coil, without consideration of the dielectric, do not give equality of inductive actions. (5) A charge of the inner cylinder by rotation of the coil, in consequence of the induction in the stationary system, is impossible. (6) Relativity between the motions with inclusion of the dielectric gives accord with the principle of relativity. [See Abstract No. 1859 (1912).] E. H. B.

511. *Statistical Electron Theory.* **J. Kroo.** (Ann. d. Physik, 42. 6. pp. 1354–1396, Dec. 23, 1913.)—Mathematical. E. H. B.

512. *Minkowski's Fundamental Equations of Electrodynamics.* II. **E. Waelsch.** (Akad. Wiss. Wien, Ber. 122. 2a. pp. 1095–1106, June, 1913.)—Quaternion and binary forms of the equations are treated. [See Abstract No. 118 (1914).] E. H. B.

513. *Moving Media.* **E. Lohr.** (Akad. Wiss. Wien, Ber. 122. 2a. pp. 1487–1580, July, 1913.)—A mathematical discussion of the electromagnetic theory by G. Jaumann for moving media. [See Abstracts Nos. 1291 (1906) and 1698 (1908).] E. H. B.

514. *Theory of Dielectric Lag.* **K. W. Wagner.** (Elektrotechn. Zeitschr. 34. pp. 1279–1281, Nov. 6, 1913.)—This theory is not concerned with the mechanism of dielectric phenomena but with their mathematical representation. The displacement in an imperfect dielectric does not instantly follow

changes in the electric field, but lags to some extent behind. The displacement D in a perfect dielectric is given by the formula $D = \lambda E/4\pi V^2$; the lag in an imperfect dielectric as shown by Hopkinson is given by $\Delta D = -(\lambda . \Delta E/4\pi V^2) . \psi(t)$, where $\psi(t)$ is a function of the time since the application of the change of field, ΔE. The function ψ can be represented according to v. Schweidler by a series of exponential terms of the form $\psi(t) = \sum_m k_m e^{-t/T_m}$, where k_m and T_m are constants which are adjusted by trial to fit the experimental results. In order that the phenomena of dielectrics may be susceptible to calculation a knowledge of the function ψ is necessary. On the analogy of the Wiechert theory of elastic creep the series is assumed to extend to ∞, and the time-constants T are supposed to be grouped in a definite manner about a most probable value T_0. This leads to a somewhat intricate expression for ψ, from which the absorption current is obtained in the form—

$$i = \int_{-\infty}^{+\infty} e^{-b^2z^2 - z - (t/T_0) . e^{-z}} . dz, \text{ where } z = \log T/T_0.$$

The absorption current is plotted from this integral for a variety of values of the characteristic constant b which measures the closeness of the distribution of T about T_0. Knowing ψ, formulæ can also be deduced which give the dependence on the frequency of capacity and of energy losses in the dielectric for alternating currents, and, further, the influence of temperature is considered. In every case the calculated curves are found to be in satisfactory agreement with the known properties of dielectrics. H. W. M.

515. *Errors in Measurements of Atmospheric Electricity.* **C. Dorno.** (Phys. Zeitschr. 14. pp. 956–960, Oct. 1, 1913.)—Confirms Bergwitz's conclusions [Abstract No. 492 (1914)]. Silvered quartz fibres are unsuitable for measuring the lower atmospheric ionisation currents on account of the unequal expansion of the quartz and the silvering, which induces strains. Measurements of penetrating radiation at various times of the day will have to be revised on account of these instrumental errors. E. E. F.

516. *The Atmospheric Potential Gradient, and a Theory as to the Cause of its Connection with other Phenomena in Atmospheric Electricity.* **W. F. G. Swann.** (Terrestrial Magnetism, 18. pp. 163–184, Dec., 1913.)—A mathematical investigation into the electrical conditions which would be expected to prevail in the atmosphere starting with the assumption of a potential which increases with height above the ground and utilising the theory of conduction of electricity in gases. Certain broad postulates are necessary. Thus the earth and the upper layers of the atmosphere are taken as two charged parallel plates, and the method of deducing the variation of force between the plates is on the lines of that adopted by J. J. Thomson in his "Conduction of Electricity through Gases." Minor assumptions necessary are that the specific velocities of positive and negative ions are equal to one another (known not to be strictly true) and that a steady state has been attained in the atmosphere. A weak point in the theory is introduced by the uncertainty as to what value should be assigned to "q" the rate of formation of ions in the air. Of the conclusions reached, some are in good agreement with the observed facts, others show some divergence and point to a modification of the theory being required, while a third class have not come within the scope of observational work in the past and suggest interesting lines for future research. With regard to the variation of potential gradient with height the theory indicates that the

gradient should fall off very rapidly in the first 15 m. above the ground, and after this the decrease becomes inappreciable. If the assumption of a fairly intensely ionised layer of air in the immediate vicinity of the ground be introduced, the deduced potential gradient would be brought more into harmony with the observed state. The theory suggests that the large fluctuations which are found to exist in the immediate neighbourhood of the ground are local effects and that much steadier conditions prevail at greater heights, say 50–100 m. J. S. Di.

DISCHARGE AND OSCILLATIONS.

517. *Flame Couples.* **G. Moreau.** (Comptes Rendus, 157. pp. 922–924, Nov. 17, 1913.)—The author has realised with pure flames, or flames charged with saline vapours, couples comparable to voltaic piles. The simplest combination is obtained by introducing into the flame of a Bunsen burner two plates of Pt, the one bare, the other covered with a deposit capable of emitting, when heated, many negative corpuscles. This deposit is obtained by fusing several mgm. of an alkaline salt or by evaporating several drops of a solution of a salt of an alkaline-earth, leaving a thin layer of oxide. The two plates serve as the electrodes of the couple : bare Pt—pure flame—sensitised Pt. If the plates are joined a current is observed of the order of 0·1 micro-amp., and it is remarkably constant when the thickness of the deposit is sufficient. There is no trace of polarisation. If E is the e.m.f. of the couple, the bare Pt being positive, and I_C the mean normal kinetic energy of a corpuscle of charge e issuing from the deposit, and I_P from the Pt, respectively, then $E = (I_C - I_P)/e$. With electrodes at 1400° abs., the following values were found for E : Electrode covered with CaO, 0·55 volt ; BaO, 0·70 volt ; SrO, 0·54 volt ; K_2CO_3, 0·68 volt ; Na_2CO_3, 0·69 volt ; RbCl, 0·56 volt. If the bare Pt electrode is cold enough for I_P to be neglected the e.m.f. E_1 should increase and be given by $E_1 = I_P/e$. Such a couple, with a cold positive electrode, can be obtained by using a Pt tube, cooled with a current of air, in conjunction with one of the sensitised electrodes maintained at 1400°. With the series : cold Pt—pure flame—Pt covered with CaO, E_1 was found to be 1·16 volts. If in this couple the sensitised electrode is replaced by a plate of bare Pt at 1400°, we have the series : cold Pt—pure flame—hot Pt noted by Becquerel, Buff, etc. Its e.m.f. $E_2 = I_P/e$. E_2 was found to be 0·55 volt. The difference $E_1 - E_2 = 0{\cdot}61$ volt. This is close to the value 0·55 volt measured for the couple : bare Pt—flame—Pt covered with CaO. Taking $e = 4{\cdot}2 \times 10^{-10}$ e.s. unit, the above formulæ give for u, the velocity of emission of corpuscles at 1400°, the values : CaO, $6{\cdot}3 \times 10^7$ cm./sec. ; Pt, $4{\cdot}4 \times 10^7$ cm./sec. The other oxides and alkaline salts give velocities between 6 and 7×10^7 cm./sec. The mass of a corpuscle is taken as $0{\cdot}8 \times 10^{-27}$ gm. Another series of couples is obtained by charging the flame with the vapour of an alkaline salt capable of being strongly ionised. The e.m.f. is always smaller than that of the corresponding couple with a pure flame, and the difference Δ increases with the concentration of the saline vapour. The resulting current also increases with the concentration of the vapour and can have a value of many microamps. A. W.

518. *Apparent Variations in the Specific Velocity of Ions of Flames with the Field.* **A. Bernini.** (N. Cimento, 6. Ser. 6. pp. 212–219, Sept., 1913.)—Although the results obtained for the specific velocity of the ions issuing from a gas-flame by the three methods of Thomson, Child [Abstract No. 847 (1901)], and Gianfranceschi [Abstract No. 927 (1906)] agree satisfactorily, yet

in all cases the value of the velocity exhibits appreciable increase with the strength of field [see Abstract No. 1714 (1911)]. It might be assumed that the variation in the potential of the flame produced by change of the strength of field would not be accompanied by any other modification in the conditions. But experiment shows that such is not the case, and the author supposes that the anomalous course of the ionic velocity originates in peculiar conditions in which, with respect to the production of ions, the flame is found according to the potential to which it is brought. Making use of an improved apparatus, in which the Thomson machine is replaced by the more simple system of a single jet and a single conductor [see Abstract No. 1405 (1912)], the author finds that the conditions of the flame are modified by change in the potential, although the nature of these modifications is not made clear. T. H. P.

519. *Residual Ionisation in Gases.* **J. C. McLennan.** (Nature, 92. p. 424, Dec. 11, 1913.)—Various observers agree that the natural ionisation in air confined in clean zinc vessels is about 8 or 9 ions per $cm.^3$ per sec. when the observations are made on land, and about 4 ions per $cm.^3$ per sec. when the observations are made directly over the surface of large bodies of water. The reduction in the number of ions per $cm.^3$ per sec. has been shown to be due to the absorption of the earth's penetrating radiation by the water [see Abstract No. 617 (1913)]. On a recent voyage from England to Canada the author made observations in a zinc vessel containing either air or hydrogen. The mean ionisation was found to correspond to the production of 4·65 ions per $cm.^3$ per sec. in air, and 1·8 in hydrogen. On land, in a building with no radio-active material in the neighbourhood, the production of ions was 8·8 per $cm.^3$ per sec. in air, and 2·0 in hydrogen. From this it follows that the penetrating radiation at the surface of the earth produces about twenty times as many ions in air as in hydrogen. Since the residual ionisation in hydrogen on the ocean was nearly 40 per cent. of that in air, it is evident that the residual ionisation in these two gases could not have been due to a radiation of the type of the earth's penetrating rays. Experiments should therefore be directed to determining whether this residual effect in gases is due to the action of an easily absorbed radiation from the walls of the vessel in which the gases are confined, or whether it has its origin in a disruption of the molecules occurring either spontaneously or through the agency of collisions. [See Abstract No. 498 (1914).] E. M.

520. *Electrical Conductivity imparted to Liquid Air by α-Rays.* **J. C. McLennan** and **D. A. Keys.** (Phil. Mag. 26. pp. 876–894, Nov., 1913. Paper read before the Roy. Soc. of Canada, May 26, 1913.)—In the experiments two electrodes, one of which was coated with polonium, were placed about 5 mm. apart in carefully filtered liquid air, and the current between them measured for different voltages. Saturation could not be obtained, but with the highest potential used, 1850 volts, the current was 1/576 of that produced in air at atmospheric pressure for complete absorption of the α-rays. It was also shown that in the absence of any ionising radiation the conductivity of liquid air is much the same as that of ordinary clean air at atmospheric pressure. Experiments were also made in the same way on the ionisation current produced in air at a pressure of 100 atmos., and in this case the max. current (with 1850 volts) was 1/16 of the saturation current in air at atmospheric pressure. The mobilities of the positive and negative ions in air at 116 atmos. were determined to be $5\cdot29 \times 10^{-4}$ and $6\cdot22 \times 10^{-4}$ respectively, the ratio

being 1·18. From various results obtained in air at high pressure the authors deduce that polonium emits an ionising radiation much more penetrating than its α-particles. E. M.

521. *Sealing-wax as a Source of Lime for the Wehnelt Kathode.* **N[ellie] N. Hornor.** (Amer. Journ. Sci. 36. pp. 591–597, Dec., 1913.)—It is shown that when Bank of England sealing-wax is used as the source of lime there is a falling off in the activity with the time. When a maximum is reached most of the electrons are emitted during the first run. When the discharge is broken while the heating current is maintained there is a slight falling off in the negative stream. These results are exactly opposite to those obtained by Willows and Picton using calcium oxide on a Pt-strip. The saturation voltage is found to be 200 volts. There is a falling off in the maxima for successive runs, and the steady current for any given run is usually much smaller than that for the preceding run with the same lime. A. E. G.

522. *Special Case of Gaseous Conduction.* **N. Campbell.** (Phil. Mag. 26. pp. 912–924, Nov., 1913.)—A theory of the conduction of electricity in an ionised gas is sketched for such experimental conditions that the effects of recombination of the ions are inappreciable compared with those of their diffusion. From the results obtained it appears that if such conditions could be realised the form of the "saturation curve" of the ionised gas should depend on nothing but the temperature of the gas. This was found to be the case with some curves obtained by the author with air, hydrogen, and CO_2 at pressures less than atmospheric. The gas was contained in a parallel-plate guard-ring condenser, the plates of which were less than 3 mm. apart, and was ionised by α- or Röntgen-rays which passed through a layer of Al-foil covering a large circular hole in one plate of the condenser. The form of the saturation curves is inexplicable on the theory of conduction which applies to cases where recombination is the important process, but is almost exactly that given by the theory referred to, being within certain limits independent of the nature and pressure of the gas, of the distance between the electrodes, and of the intensity of the ionisation. The limits are probably set by the influence of recombination on the one hand, and on the other, by the finite initial velocities of the δ-rays emitted in ionisation. Certain inexplicable anomalies were found when hard β- and γ-rays were used for ionisation. These anomalies are connected with certain peculiar actions taking place at the metal electrodes, which, it appears, do not always absorb all the ions falling on them. By sooting the metal plates of the condenser curves similar to those with α- and Röntgen-rays were obtained. F. J. H.

523. *Origin of Thermal Ionisation from Carbon.* **J. N. Pring.** (Roy. Soc., Proc. Ser. A. 89. pp. 344–360, Nov. 1, 1913.)—It has been shown by the present author and A. Parker that the ionisation which is produced by carbon at high temperatures, and in the presence of gases at low pressures, is reduced to a much smaller order of magnitude by eliminating impurities from the carbon, and by exhausting to a high degree the containing vessel [Abstract No. 542 (1912)]. These results threw considerable doubt on the whole basis of the theory of electronic emission from incandescent solids. In discussing these results Richardson admits that the ionisation originally measured by him in the case of carbon was largely influenced by the presence of impurities leading to chemical reaction. The result of this was to lead to an abnormally high value being given to the constant A in the expression $A\theta^{1/2}\epsilon^{-Q/2\theta}$ which was deduced to represent, on the basis of the thermionic theory, the relation between ionisation and temperature. By revising the constants from which the values in this formula are derived, the formula was made to follow much more closely the experimental results of Pring and Parker, though it still gave values considerably higher than the latter, and did not agree with the observed influence of temperature. It was, however, maintained that the fundamental theory put forward by Richardson, accounting for the relation between ionisation and temperature, was not disturbed. The aim of the present work is to see if any direct electronic emission can be attributed to incandescent carbon, when the large ionisation effects, which were found in the earlier work to be due to chemical action, are more completely removed. For this purpose the purification of the carbon and the exhaustion of the surrounding vessel are carried out more extensively than before, and the effect on the ionisation at definite temperatures is carefully measured. A series of experiments is also made in which small quantities of the highly purified gases—He, Ar, N, CO, CO_2 are admitted to the vessel at known pressures to see if any relation could be traced between the ionisation and the relative chemical action of these gases on carbon. The results show that the large currents hitherto observed were derived from some reaction between the carbon and the gas. It is also shown that a still further reduction in the ionisation is brought about by eliminating further the absorbed gases from the carbon. By admitting known amounts of different pure gases to the carbon the ionisation produced is directly proportional to the known chemical activity of these gases. The progress of absorption of the gas by the carbon and its evolution can, moreover, be traced by ionisation currents. While it is difficult to prove definitely that there is no electronic emission from the heated carbon itself, it is obvious that it is exceedingly small compared with the ionisation which can be attributed to ordinary chemical change. The small residual currents which are observed in high vacua after prolonged heating are not greater than would be anticipated when taking into account the great difficulty of removing the last traces of gas. A. E. G.

524. *Theory of Ionisation by Collision.* **B. Davis.** (Ann. d. Physik, 42. 4. pp. 807–814, Nov. 4, 1913.)—The author first recapitulates his theory for the minimum kinetic energy which a negative ion must have in order to ionise a molecule by impact [Abstract No. 295 (1907)]. It is shown that if a is the number of ionising impacts which a negative ion makes in passing through 1 cm. of a gas, l the mean free path of the ion, X the potential gradient, λ_0 the minimum path which results in ionisation, so that $X\lambda$ is the ionising potential, then—

$$al = \epsilon^{-\frac{\lambda_0}{l}} + \frac{\lambda_0}{l}\,\mathrm{E}i\left(-\frac{\lambda_0}{l}\right),$$

where Ei represents the exponential integral. The mean free path, l, is $4\sqrt{2}$ times the mean free path of the molecules of the gas, the factor 4 arising from the assumption that the electron behaves as a point and the factor $\sqrt{2}$, because under the influence of the electric field the electrons velocity is greater than the velocity of agitation of the molecules. It is deduced from the fact that experiment agrees with theory [Abstract No. 365 (1912)] which assumes a spherical molecule, that probably the electron does not actually touch the molecule, but gets to such a distance that its repulsion of the electrons of the molecule is operative. As it is extremely improbable that the molecule is actually spherical, it would appear that the resultant field of its electrons has a spherical distribution. **E. M.**

525. *Potential Attained by Photoelectric Cells in Darkness.* **J. W. Woodrow.** (Phys. Rev. 2. Ser. 2. p. 198, Sept., 1913.)—The author made some experiments which seemed to show that strongly photoelectric metals liberated positive particles when kept in total darkness [see Abstract No. 111 (1913)]. Further experiments were made to determine the exact nature of the charge obtained from the photoelectric metal, and it was shown conclusively that this charge was due to a leak across the surface of the glass insulation, from the potassium which will be at a positive potential with respect to the Pt electrode. The increased current at the higher temperatures is probably due to the increased conductivity of the glass and the condensation of the vapour of the metal on the walls of the cell. S. H. Anderson has shown that with alternating fields applied to a photoelectric cell in darkness there is no indication of the current which would be expected if the metal liberated any kind of positive particles. J. J. S.

526. *Abnormal Electric Dispersion.* **E. Schrödinger.** (Deutsch. Phys. Gesell., Verh. 15. 22. pp. 1167–1172, Nov. 30, 1913.)—A theoretical discussion reaching the following suggestions as to the requisite experimental researches. (1) The influence of temperature on the middle part of the dispersion curve should be investigated. (2) The researches of Colley and Obolensky should be continued and extended over as large a part of the spectrum as possible. [See Abstract No. 446 (1913) and **P. Debye**, Ibid. 15. 16. p. 777, 1913.] E. H. B.

527. *Canal-ray Secondary Radiation.* **H. Baerwald.** (Ann. d. Physik, 42. 6. pp. 1287–1310, Dec. 23, 1913.)—A comparison of the author's methods and results with those of Füchtbauer. A. E. G.

528. *Radiation of Electric Waves in Dispersive Media.* **W. Esmarch.** (Ann. d. Physik, 42. 6. pp. 1257–1272, Dec. 23, 1913.)—A theoretical investigation in which the following points are specially noteworthy. (1) Two methods are developed which express the secondary waves generated by the passage of plane waves in a medium laden with electrons. The superposition of the primary wave on those sent out from these electrons gives a progressive wave whose extinction and phase velocity agree with the known values on the ordinary dispersion theory. (2) The reflected wave arises at all places in the medium traversed by the incident wave and not only in the neighbourhood of the limiting layer. E. H. B.

529. *The Virtual Anode in Tubes for Magnetic Rays.* **A. Righi.** (Accad. Lincei, Atti, 22. pp. 256–263, Sept. 28, 1913. Phil. Mag. 26. pp. 848–857, Nov., 1913.)—Experiments show that, through the action of the magnetic field there appears, with unusual extension, a beam of kathodic rays known as kathodic rays of the second kind, or magnetokathodic rays, or magnetic rays, and that on the prolongation of them another one may appear having the colour and character of the positive column of the usual discharge. To this column, which constitutes a second phenomenon due to the magnetic rays, More and Rieman gave the name of "induced column." But as there is in this case no real phenomenon of induction, it is now suggested to change the name to "secondary column." The principal experiment is carried out by observing the action produced on the secondary column by a feeble transversal magnetic field obtained, for example, by means of a coil. The effect which may be observed is a deformation of the secondary column such as might be produced if, in a given region of the same, an anode (virtual anode) existed and two kathodes were at the ends of the tube. Assuming the truth of the author's theory of the nature of the magnetic rays this virtual anode may be explained as follows :—The pairs ion-electron are incessantly destroyed through molecular collision, but new ones are formed in a quantity which decreases as we go towards the places where the intensity of the field becomes less. Thus it happens that positive ions and electrons produced by the scission of the doublets are driven by their speed towards the bottom of the tube, which most of the latter will easily reach, while the positive ions will stop before then and form the virtual anode. The place where these positive ions arrive depends on the speed impressed on the doublets by the magnetic force, and, consequently, it depends (1) on the area enclosed by the orbits of the electron satellite; (2) on the speed with which it is moving in this orbit; (3) on the mass of the positive ion. A comparison of the curves relative to the various gases certainly leads to the conclusion that the distance of the virtual anode from the kathode depends on the mass of the positive ion. Results of some interest are also obtained by using gaseous mixtures. The causes why More and Rieman failed to obtain constant results are considered, and More and Mauchly's work is also discussed. [See also Abstract No. 219 (1913).] A. E. G.

530. *Occluded Gases in Vacuum Tubes.* **R. W. Lawson.** (Phys. Zeitschr. 14. pp. 938–941, Oct. 1, 1913.)—Brings forward further evidence in favour of the persistent occlusion of gases in vacuum tubes [see Abstract No. 879 1913)]. After 12 hours' discharge and subsequent exhaustion, a vacuum tube with Pt electrodes showed an intense spark spectrum of oxygen. Aluminium electrodes could not be made to yield oxygen, Ne, Ar, or He. CO was evolved for many hours from Al electrodes, but not from Pt electrodes. There were traces of hydrocarbons, indicated by the band 4315 Å., but these were always occluded in the capillary tubes, not in the electrodes.
E. E. F.

531. *Electric Discharge Phenomena in Rotating Silica Bulbs.* **R. J. Strutt.** (Roy. Soc., Proc. Ser. A. 89. pp. 340–344, Nov. 1, 1913.)—The late F. J. Jervis-Smith described some experiments on this subject, without, however, offering any interpretation of his results [see Abstracts Nos. 884 and 1322 (1908)]. His fundamental experiment was one in which the exhausted bulb is placed near a body charged to 1000 volts or more. When the bulb is rotated, a luminous glow is maintained within it. This is now explained by the flow of induced currents inside the bulb. In Jervis-Smith's third paper he describes luminosity produced by rubbing the outside of the rotating silica vessel. The cause of luminosity is shown to be not materially different from what it was in the previous case. If a brush discharge from an induction coil is merely allowed to play over a highly exhausted silica bulb, the bulb remains brightly luminous, sometimes for several minutes. This is shown to be connected with electrification of the outside surface. In another experiment of Jervis-Smith a silica glow bulb was rotated as before. The camelhair rubber, after being in contact with the bulb, was removed, and no glow was visible; but on establishing the magnetic field (about 800 c.g.s. units intensity), the bulb instantly

glowed brightly, the glow lasting in some cases 8 mins. before it died out. When pointed pole-pieces were used on either side of the rotating bulb, a bright equatorial band about 5 mm. wide of greenish glow was generated. The explanation now offered is that each pole of the magnet, acting merely as an earthed conductor, lowers the potential of the inner surface of the bulb near it, so that these two portions of the surface tend to act as kathodes.

The electric force may not be enough to cause discharge, but when the magnet is excited it produces a magnetic force parallel to the electric force, and this, as is known, lowers the discharge potential so that discharge can occur. At the same time a beam of "magnetic rays" proceeds from each kathode towards the other, along the magnetic lines. These constitute the luminous band described. A. E. G.

532. *Low-potential Discharges in High Vacua.* **J. S. Townsend.** (Phil. Mag. 26. pp. 730–732, Oct.. 1913.)—The paper is a discussion of the explanation given by Strutt of the low-potential discharge in high vacua which he obtained by means of a magnetic field [see Abstract No. 1866 (1913)]. Attention is first drawn to the mistake made in considering that the electrons leaving the kathode in an ordinary vacuum tube are unable to ionise the gas until they have fallen through the kathode fall of potential. Measurements of the effects obtained by collisions show that an electron ionises a molecule when it collides with a velocity acquired under a potential-fall of 25 volts, so that many of the molecules in the dark space are ionised. An explanation of the effect of the magnetic field is then given which obviates the necessity for distinguishing between electrons which have travelled through large distances and those which have travelled through small, but which have fallen through the same p.d. In the high vacua of Strutt's experiments the electrons produce very little effect in traversing the distance between the concentric cylinders when the magnetic field is zero, since they meet with so few molecules. The number of collisions in the spiral path when the magnetic field is on is, however, very much larger, so that the effect of the magnetic field is the same as if the pressure were increased in the ratio of the two paths so far as ions generated by electrons are concerned. The p.d. required to produce the discharge is thus reduced to the value corresponding to a higher pressure. F. J. H.

533. *Low-potential Discharges in High Vacua.* **F. Horton.** (Phil. Mag. 26. pp. 902–905, Nov., 1913.)—During some recent experiments made by the author, the effect of a transverse magnetic field upon the negative emission from heated salts was observed under varying conditions of gas pressure and voltage. The results of a typical experiment are quoted, and shown to be in keeping with the theory of ionisation by collision, thus bearing out Townsend's explanation [see preceding Abstract] of the low-potential discharge obtained by Strutt. F. J. H.

534. *Energy Transferred by Electromagnetic Waves.* **M. Reich.** (Phys. Zeitschr. 14. pp. 934–938, Oct. 1, 1913.)—Quotes the result of some experiments made between Göttingen and either Cologne or Strassburg, which show that Hertz's theory of electromagnetic radiation is substantially corroborated. The discrepancies between the theoretical and experimental values of the energy transmitted are attributable (1) to the fact that transmitter and receiver are not placed on perfectly conducting ground, and (2) to an absorption of energy by the intervening landscape. The absorption of energy is the same for damped and undamped waves, and increases strongly with decreasing wave-length. The absorption amounted to 57 per cent. in transmitting a 2000-m. wave from Cologne, 58·7 per cent. from Neumünster, and 54 per cent. from Strassburg, where the Rhine favours transmission. On mounting a single wire 87 m. in effective height at Göttingen, a sending current of 15 amps. at Cologne gave a received current of $4{\cdot}34 \times 10^{-4}$ amp. at Göttingen. The value calculated on the basis of previous results was $4{\cdot}2 \times 10^{-4}$. E. E. F.

535. *The Theory of Oscillation Circuits.* **N. Bulgakov**. Acad. Sci. St. Pétersbourg, Bull. 2. pp. 125–132, Feb. 1, 1914.)—The important case when there is a spark-gap in the secondary is discussed. The resistance of the secondary circuit is supposed to be of the form $R/(1 - at)$, so that R is its resistance at time 0, and its resistance at time $1/a$ is infinite. The complete mathematical solution of the equation is obtained. A. R.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

536. *Thermal and Electric Peculiarities of Bismuth and Antimony Alloys.* **G. Gehlhoff** and **F. Neumeier**. (Deutsch. Phys. Gesell., Verh. 15. 17. pp. 876–896, Sept. 15, 1913.)—The thermal and electric conductivity as well as the thermo-e.m.f. of alloys of Bi and Sb were investigated between − 190° and + 100° C. The method of measurement of the thermal conductivity was similar to that adopted by C. H. Lees [Abstract No. 1677 (1908)]. As the percentage of Bi decreases from 100 % and that of Sb increases, the conductivity for heat at first decreases and then rises steadily till the material consists entirely of Sb. The explanation of Kœnigsberger seems probable, viz. that in heat conduction in contradistinction to electric conductivity, besides the electrons the ponderable molecules also take part, and that the law of Wiedemann and Franz depends only on the process which is due to the behaviour of the electrons. The view of Kurbatow that the condition as to conductivity is only constant for each group of metals in Mendelejeff's system must be regarded as disproved by the results obtained by the authors. The quotient Λ/KT of the law of Lorentz shows, for the single alloys corresponding with the pure components, from the temperature of liquid air and upwards a decrease, and afterwards an increase in value. The capacity of heat for alloys which exhibit a solid solution, appears, from the observations made, to be a strongly additive quality as has been already stated by Saposchnikow. J. J. S.

537. *Electrical Conductivity of Anisotropic Liquids in Magnetic and Electric Fields.* **T. Svedberg**. (Ark. för Mat. Astron. och Fysik, Stockholm, 9. No. 9. pp. 1–15, 1913.)—The electrical conductivity of anisaldazine is influenced distinctly by a magnetic field up to 4850 gauss. If the magnetic field is longitudinal and of increasing strength there is at first a slow and then a rapid increase of conductivity, followed by a further slow increase which is roughly proportional to the strength of the field. In a transverse field the alterations are nil when small voltages are used to measure the conductivity, but under larger voltages the transverse magnetic field produces effects similar to those of the longitudinal field, although opposite in sign; if the voltages are above 20, the effects are almost equal and opposite. These effects are limited to the range, 166 to 177° C., of the anisotropic-liquid state. In the anisotropic state the current increases more rapidly than the voltage. On passing to the isotropic state the conductivity at low voltages increases, whilst that at high voltages decreases. T. M. L.

538. *Dielectric Constant of Hydrogen at High Pressures.* **A. Occhialini.** (Accad. Lincei, Atti, 22. pp. 482–484, Nov. 23, 1913.)—The methods previously described [see Abstracts Nos. 539, 1048, and 1496 (1913)] have been used to measure the dielectric constants, K, and the densities, *d*, referred to that at normal temperature and pressure, of hydrogen under various pressures. The results are as follows, the values in the three last columns referring to a temperature of about 24°.

Pressure (approx.) in Atmos.	d	K.	$\frac{K-1}{d}\times 10^7$	$\frac{K-1}{K+2}\cdot\frac{1}{d}\times 10^8$
94	80	1·02180	2725	9018
117	100	1·02730	2730	9018
144	120	1·03280	2733	9012
169	140	1·03835	2739	9015
196	160	1·04390	2744	9014

Extrapolation gives the value 1·0002705 for K under atmospheric pressure, Tangl [see Abstract No. 1143 (1908)] having found 1·000273. The mean value for $(K-1)/(K+2)d$ is 90154×10^{-9}, the value obtained by Tangl for measurements at 20–100 atmos. being 903×10^{-7} (898–908×10^{-7}). T. H. P.

539. *Dielectric Constant of Nitrogen at High Pressure.* **E. Bodareu.** (Accad. Lincei, Atti, 22. pp. 480–482, Nov. 23, 1913.)—By the methods previously described [see Abstracts Nos. 539, 1048, and 1496 (1913)] the author has measured the dielectric constants, *k*, and densities, *d*, of nitrogen at high pressures, the mean results being as follows :—

Pressure (approx.) in Atmos.	d.	k.	$\frac{k-1}{d}\times 10^7$.	$\frac{k-1}{k+2}\cdot\frac{1}{d}\times 10^7$.
87	80	1·04750	5938	1949
114	105	1·06276	5978	1952
143	130	1·07828	6022	1956
174	155	1·09373	6047	1955
205	180	1·10953	6085	1957
226	195	1·11867	6086	1952

The values in the last two columns correspond with a temperature of about 28°. The densities are referred to that of nitrogen at 0° and 760 mm., and the pressures are calculated from Amagat's table. Tangl [see Abstract No. 1143 (1908)] found the values 1935 for $(k-1)10^7/(k+2)d$ and 1·000581 for the dielectric constant at 1 atmo. pressure, while the number 1·000587 is obtained by extrapolation from the author's results. T. H. P.

540. *The Thermal Coefficient of Contact E.M.F.* **H. C. Burbridge.** (Phys. Rev. 2. Ser. 2. pp. 183–197, Sept., 1913.)—Experiments were made on the change produced in the contact p.d. when change of temperature occurs. A Dolezalek electrometer and a condenser consisting of sliding cylinders were employed. Copper, Ni, Zn, Sn, and Al were investigated, and oxidation effects were noticeable which have to be allowed for in estimating the change due to rise of temperature. Further experiments on other metals and with a wider range of temperature may be carried out later. The values for the coefficient are given in the following table :—

Metal.	Temp. Range.	Coefft., Volts per deg.
Cu	20 to 70°	0·00050
Ni	20 to 90°	0·00036
Zn	20 to 55°	0·0024
Sn	20 to 45°	0·00096
Sn	45 to 90°	0·0020
Al	20 to 40°	0·0011
Al	40 to 70°	0·0023
Al	70 to 90°	0·0036

J. J. S.

541. *On the Self-inductance of Circular Coils of Rectangular Section.* **T. R. Lyle.** (Roy. Soc., Phil. Trans. 213. pp. 421–435, Jan. 31, 1914.)—Maxwell gave the formula $L = 4\pi a n^2[\log_e(8a/r) - 2]$ for the self-inductance of a coil of rectangular section, where a is the mean radius and r the geometric mean distance of the section of the coil from itself ; the current being supposed to be uniformly distributed over the section. The author shows that the same formula will give the self-inductance to any order of accuracy when in it are substituted for a and r the mean radius and the G.M.D. respectively, each suitably modified by small quantities which depend on a and on the section of the coil. Tables are given by means of which the modified values of a and r for any coil of rectangular section can be found. These values when substituted in the above formula give L correct to the fourth order, uniform current density over the section being assumed. A. R.

542. *Experiments on Potential Difference.* **S. Magrini.** (N. Cimento, 6. Ser. 6. pp. 173–178, Sept., 1913.)—The experimental arrangement is described, by which the p.d.'s between various points of a uniform wire, in which a steady current is flowing, are indicated by capillary electrometers of the horizontal type. The p.d.'s are proportional to lengths of wire, and, therefore, to the resistances between the points considered. A modification is also given, in which the electrometers are joined electrolytically to two points in the interior of a cell. This is formed of a U-tube with the electrometer tubes sealed into its limbs, the electrodes being situated at the upper ends of the limbs. The p.d.'s within the cell are as would be expected, both when the current is flowing and when it is not. S. G. S.

543. *Lag and Lead demonstrated with a Braun Tube.* **J. F. Mohler.** (Science, 39. p. 210, Feb. 6, 1914.)—Describes a new method of illustrating the lag and lead in an alternating-current circuit due to inductance or capacity. A Braun tube is excited by an induction coil with its vibrator adjusted to a period which is nearly a multiple of that of an alternating current flowing in two solenoidal circuits. These solenoids are placed with their axes perpendicular to each other and to the axis of the tube. The stroboscopic effect then causes the spot of light on the screen to move slowly back and forth in a straight line until a considerable inductance or capacity is

introduced into one of the solenoidal circuits, whereupon the spot describes an ellipse varying in width according to the amount of the inductance or capacity introduced. J. W. T. W.

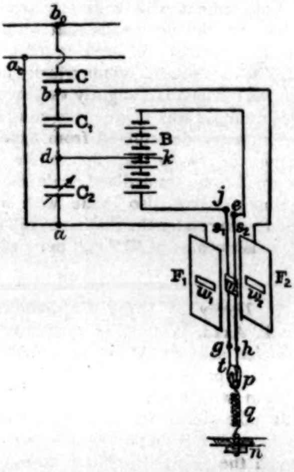
544. *Electrometry with the Displacement Interferometer.* **C. Barus.** (Amer. Journ. Sci. 37. pp. 65–86, Jan., 1914. Abstract from Report to Carnegie Inst. of Washington.)—Examines the sensitiveness of various forms of absolute electrometer, the motion of the movable conductor being measured by means of a displacement interferometer. Three forms of electrometer were used: (i) and (ii) concentric cylinders with the movable cylinder within and without respectively, and (iii) parallel discs. In every case a bifilar suspension was used for the movable conductor. Equations are theoretically deduced for these cases and for that of a closed-field electrometer (discs and cylinder combined). The experimentally determined voltages in cases (i) and (ii) are in close agreement with voltmeter readings, but the greatest sensitiveness obtainable was by no means that to be expected from the formulæ, being of the order of 0·05 volt per ring (of the interferometer). In case (iii), with the movable disc placed symmetrically between the fixed ones, the voltage found from the formula is a slightly varying multiple of that given by the voltmeter. This multiple was made more constant by giving the disc a certain degree of asymmetry determined from experiments on a known voltage. The sensitiveness is greater than that of the cylindrical forms, but is still not sufficiently great to be immediately valuable for refined practical measurements. Experiments were also made with an ordinary quadrant electrometer so modified as to render the motion of the needle measurable by the interferometer. A sensitiveness of 10^{-5} volt per ring was obtained.

J. W. T. W.

545. *Contribution to Theory of String Galvanometer.* **J. K. A. W. Salomonson.** (Konink. Akad. Wetensch. Amsterdam, Proc. 16. pp. 522–539, Dec. 27, 1913.)—Stefan showed (Wied. Ann. 1889) that, in an electromagnet, the field in the interpolar space would be increased by giving the pole-pieces a conical form with a top angle of about 110°. In the string galvanometer, prismatic pole-pieces are used, and it is shown that about the same value holds for the top angle of such poles. When a constant current is passed through the string, the latter assumes catenary form, and if the field is constant over the length of the string the curve is parabolic. Particulars are given of the exploration of the field of an Einthoven galvanometer magnet by means of a Cotton balance and a bismuth spiral. Finally, an expression is found by two methods, for the "active" field strength of the magnet, viz. $H = 32N^2h\pi r^2g/I$, where N is the frequency of the wire, h its lateral displacement, r its radius, and I the current in it. G. E. A.

546. *The Vibration Electrometer.* **H. Greinacher.** (Elektrotechn. Zeitschr. 34. pp. 1485–1486, Dec. 25, 1913.)—In continuation of his work on the use of the Wulf electrometer for alternating-current bridge tests [see Abstract No. 1579 (1912)] the author now shows how it may be used in connection with measurements of electrical and magnetic fields. Thus for measurements in the former case a simple wireless system is used in which the sender and receiver are upright metal rods. On exciting the transmitter the receiver, which is connected directly to the fibres of the electrometer, causes the fibres to be thrown into vibration. The vibration can be increased by introducing between the sender and receiver a slab of some dielectric. Thus the apparatus is suitable for the measurement of the dielectric constant. A disadvantage of the use of such an instrument for alternating work is that the platinum soon peels off the quartz fibre. The author has therefore constructed a special vibration electrometer in which he uses a Pt-wire of thickness 5 μ as the vibrator; a description of the instrument is given in the original. W. C. S. P.

547. *An Electrostatic Oscillograph.* **H. Ho** and **S. Koto.** (Phys. Soc., Proc. 26. pp. 16–26; Discussion, pp. 26–27, Dec., 1913. Electrician, 72. pp. 290–291, Nov. 21, 1913. Abstract. Electrical World, 62. p. 1340, Dec. 27, 1913. Abstract.)—The voltage to be measured between a_0 b_0 is applied to two parallel metallic field-plates F_1, F_2. C is an oil condenser to be used, if necessary, for reducing the said voltage to a suitable value at the terminals a, b of the oscillograph. Two bronze strips s_1, s_2 are stretched between the field plates and are parallel to one another and the plates and carry a mirror m; the tension can be adjusted in the usual way. The two strips are insulated from each other by silk thread t which passes over an ivory pulley p, thus forming two electrically independent conductors. w_1 is an opening for the passage of light to the mirror, w_2 being a similar one in F_2 in order to maintain the symmetry of the electric field. The plates and strips mounted on an ebonite frame are immersed in an oil bath. The oil not only acts as a damping agent but increases the sensitiveness owing to its high dielectric constant. In parallel with the field plates are the oil condensers C_1, C_2, the latter being adjustable. The mid point of a battery B of small cells (300 volts) is connected to d and its terminals are connected to the strips to charge them, just as the needle of a quadrant electrometer is charged. The turning moment on the strips is proportional to the product of the momentary values of the alternating-current voltage and the direct-current voltage. With this arrangement voltages up to 9000 have been measured. The sensitiveness is such that for an effective voltage between



field plates of 2000 and a battery of e.m.f. 800 volts a wave of 2 cm. amplitude was obtained at a distance of 70 cm., when the vibrator was adjusted to its natural period of 1/3800 sec. In working with an electromagnetic oscillograph at high voltages using a "non-inductive" resistance in series with the latter vibrator there is a decided capacity current. This is brought out clearly by means of two curves obtained by working the electrostatic and electromagnetic vibrators in parallel. In cases where the voltage is low but the source of energy is so limited that sufficient current cannot be taken to actuate an ordinary oscillograph, the electrostatic vibrator may be used by applying the voltage to the strips while the terminals of a high-tension battery or influence machine are connected to the field plates. Very small currents may also be recorded by replacing the oil condensers by two exactly equal resistances which are traversed by the current.

The instrument is now constructed by the Cambridge Scientific Instrument Co. W. C. S. P.

548. *Mercury Lamp.* **Billon-Daguerre, L. Medard,** and **H. Fontaine.** (Comptes Rendus, 157. pp. 921–922, Nov. 17, 1913.)—Describes a new form of water-cooled mercury lamp, giving practically cold light. The lamp is composed principally of a cylindrical or flat tube of inverted U-form, the ends being curved up again to carry the tubes for the electrodes. This U-tube is placed inside a flask of special form with a long vertical neck closed by a ground stopper. The whole is of fused quartz, pure and transparent; the electrodes are of invar. The wall of the flask on the side opposite to that to be used for light has the form of a paraboloid and can be silvered to form a reflector for concentrating the light. The whole is immersed in a bath of water. The lamp will take a current of 18 amps. with 70 volts across its terminals. Various advantages and applications are noted. A. W.

549. *Electrometer of High Sensitiveness.* **G. Hoffmann.** (Ann. d. Physik, 42. 6. pp. 1196–1220, Dec. 23, 1913.)—A paper giving further details and theory of the author's sensitive electrometer previously described. [See Abstracts Nos. 1488 (1912) and 609 (1913).] A. W.

ALTERNATING CURRENTS AND MAGNETISM.

550. *Alternating Magnetisation at High Frequencies.* **C. E. Guye** and **[Miss] A. Albert.** (Archives des Sciences, 37. pp. 20–36, Jan., 1914.)—The current from an alternator was passed through the primary wound on a torus of fine iron wire, and the effective e.m.f. in the secondary was measured by means of an electrostatic voltmeter. Frequencies (n) of 1200, 600 and 300 were employed in conjunction with secondary windings numbering N, where N varied in the ratio 1 : 2 : 4, so that the product nN was constant. The combined results show that the rapidity of variation of the magnetic field has no appreciable effect on the magnetisation curve. The fields varied between 8 and 25 gauss. G. E. A.

551. *Measurement of Magnetic Fields.* **P. E. Klopsteg.** (Phys. Rev. 2. Ser. 2. pp. 390–399, Nov., 1913.)—The method described depends on the damping effect of the field on a vibrating coil. An expression for the field strength is derived from the equation to a damped simple harmonic motion, in terms of the logarithmic decrements of the coil with closed and open circuits respectively. The case for which the coil is critically damped, *i.e.* becomes aperiodic in its motion, is also worked out. The equations are

verified experimentally, and an accuracy of 1 per cent. is obtained for the determination of H from the periodic motion, for fields of 1 to 1500 c.g.s. [See also Abstract No. 1446 (1903).] G. E. A.

552. *Magnetisation of Iron at Low Inductions.* **L. W. Wild.** (Inst. Elect. Engin., Journ. 52. pp. 96–105, Dec. 15, 1913.)—A description of tests carried out on samples of lohys (mild steel) and stalloy (silicon steel) transformer steels, built up into magnetic squares. Both direct and alternating currents were used; with the former, B was given by means of a ballistic galvanometer, and with the latter, B was measured with a combination of rectifier and calibrated galvanometer. The experiments led to the following conclusions:—Subjecting the iron to demagnetising treatment has a kind of loosening effect on the molecular magnets, so that directly afterwards reversing the magnetising force leads to an abnormal change of flux and an abnormally high permeability. The effect wears off in about 48 hours. At flux densities between 1 and 100, the process of demagnetisation is so slow that no ordinary ballistic galvanometer can include the whole change of flux on reversal of the magnetising force. When the reversal of force is divided into two parts, the change of flux takes place even more slowly than on a simple reversal, so that attempts to measure the hysteresis loss ballistically are likely to be very misleading. Permeability on alternating current is sensibly the same at 50 as at 25 ∿. Ballistic permeability is higher, and true continuous-current permeability the highest of all. The hysteretic index is about 3 on alternating current between $B_{\text{max.}}=1$ and $B_{\text{max.}}=10$. Above the latter figure the index declines, but is still above 2 at $B_{\text{max.}}=100$. On alternating current, hysteresis loss is present down to $B_{\text{max.}}=0$, although no retentiveness could be detected below $B_{\text{max.}}=1$ on ballistic tests. [See also Abstract No. 1203 (1913).] G. E. A.

553. *Relation of the Specific Heats and Melting-points of certain Alloys to their previous Thermal History and, in the case of Heusler Alloys, to their Magnetic Properties.* **E. Dippel.** (Ann. d. Physik, 42. 5. pp. 889–902, Dec. 2, 1913. Extract of Dissertation, Marburg.)—Heusler discovered that in certain malleable copper-rich Al bronzes hysteresis can be developed to a greater or lesser extent by suitable heat-treatment. These qualitative observations were subsequently confirmed quantitatively by Asteroth [Abstract No. 683 (1908)], who showed that the hysteresis is always greater in slowly cooled and aged alloys than in quenched and aged alloys. Richarz concluded that slow cooling aids, and quenching prevents, the formation of complex molecular aggregates. Now if this view be correct certain alloys should show lower specific heats when slowly cooled than when rapidly cooled, since the formation of a complex diminishes the molecular freedom in the kinetic sense and so causes a lowering of the specific heat. Experiments with an alloy of 93 % Pb and 7 % Bi showed that slowly cooled samples actually possessed a lower specific heat than rapidly cooled samples. It was also found that the melting-point of this alloy could be varied between 301·5° C. and 305° C. according to the thermal treatment it had received. Experiments were also made with a Heusler alloy containing 14·25 % Mn, 10·15 % Al, small quantities of Fe and the residue Cu. Two samples were forged, annealed, quenched, and aged. The specific heat of the slowly cooled alloy was found to be appreciably lower than the quenched alloy. Short ageing slightly increases, but prolonged ageing decreases, the specific heat. These phenomena are discussed in relation to the magnetic phenomena observed by Take. F. C. A. H. L.

554. *Longitudinal Thermomagnetic Potential-difference.* **A. W. Smith.** (Phys. Rev. 2. Ser. 2. pp. 383–389, Nov., 1913.)—When a plate along which heat is flowing is subjected to a transverse magnetic field, the p.d. between two points on the length of the plate is increased or diminished by the amount $e = L \, . \, H(t_1 - t_2)$, where H is the field, $t_1 - t_2$ the temperature difference, and L the coefficient of the effect. Zahn found L to increase with rise of temperature [see Abstract No. 3263 (1904)]. The author finds that his result is not in agreement with the observations of Zahn. The potential gradient set up by the magnetic action is in the opposite direction to the temperature gradient of the plate, and the value of L diminishes with rise of temperature, probably vanishing at the melting-point of Bi. The value of L found for 58° C. was 0·102 in a field of 9600 c.g.s., which agrees well with Barlow's value of 0·100 in a field of 11,000. The effect in graphite is positive and much smaller than in bismuth. The effect in monel metal, an alloy of Ni, Cu, Fe, and Mn, is also positive. In the case of Bi-Sb alloys, the effect is greatest when the alloy contains about 9 per cent. of Sb. [See also Abstract No. 79 (1912).] G. E. A.

555. *Magnetic Field of Two Electromagnets in Rotation.* **S. J. Barnett.** (Phil. Mag. 26. pp. 987–991, Dec., 1913.)—For these experiments two similar cylindrical electromagnets were mounted with their axes in the same straight line, and were so magnetised that the lines of induction stretched across from one of the adjacent poles to the other. A small elongated cylinder of iron was so mounted at the point of the field under investigation as always to follow any change (of the sort under test) in the direction of the intensity at the point, and a mirror attached to the magnet's support and other optical appliances made it possible to determine any change in the magnet's orientation with great precision. The magnets were driven at about 80 revs. per sec., and the field was about 1200 gauss. The change in direction of a line of the field owing to this rotation was very small, the mean value observed being about one second of arc. [See Abstract No. 115 (1914).] E. H. B.

556. *Theory of Thermomagnetic Effects.* **H. Zahn.** (Phys. Zeitschr. 14. pp. 926–928, Oct. 1, 1913.)—In view of the difficulties attending the electron theories of the thermomagnetic effects in metals, the author advances a new explanation based upon the "bound" electrons. These, when revolving in the plane perpendicular to the magnetic field, may be taken to represent two equal and opposite currents which as a rule are accurately compensated. Any difference of temperature along the plate produces a difference in the density of free electrons, and the resulting current exerts opposite forces upon the two quasi-currents referred to, this producing a lateral component of the e.m.f. The author does not formulate this theory analytically, and anticipates some difficulty in doing so. E. E. F.

557. *The Molecular Field and a Law of Action inversely as the Sixth Power of the Distance.* **P. Weiss.** (Comptes Rendus, 157. pp. 1405–1408, Dec. 22, 1913.)—The molecular field imagined by the author to render ferromagnetic phenomena accessible to the kinetic theory is defined by the expression, $H_m = N \, . \, I = N \, . \, D \, . \, \sigma$, where I is the intensity of magnetisation, N the constant of the molecular field, D the density, and σ the specific magnetisation. Although this has proved itself a fertile hypothesis, yet it is impossible to conceive of this molecular field as a true magnetic field; the forces may indeed be of any nature whatsoever. Investigation of a substance formed of given molecules of all densities should give the law of variation with the distance of the actions producing the molecular field. This question is resolved, at least in a particular case, by means of alloys of the ferromagnetic metals. With the systems iron-cobalt, iron-nickel, and nickel-cobalt the variation of the coefficient N with the composition is either linear or distinctly non-linear, the former being probably characteristic of metals of unlimited reciprocal solubility. Where one of the metals is magnetically neutral and serves merely to dilute the other, the coefficient N is proportional to the density of the magnetic metal in the alloy, and hence the molecular field, H_m, for a given specific magnetisation, is proportional to the square of the density. This variation of density may be obtained by amplifying all the distances in a ratio λ. The molecular field, multiplied by λ^{-6}, is a homogeneous function of the minus sixth degree of the distance. If the elementary action of a molecule on a neighbouring molecule be regarded as developed in a series according to the powers of the distance, either the sixth power must exist alone or the other powers must disappear in the summation extended to the sphere of molecular action. The law of action thus found shows that the molecular field is neither magnetic nor electrostatic, and that it is produced by molecular actions of new type and unknown character. T. H. P.

558. *Electromagnetic Fields in Ferromagnetic Metals.* **W. Arkadief.** (Phys. Zeitschr. 14. pp. 928–934, Oct. 1, 1913.)—This is a sketch of a theory of electromagnetic actions in ferromagnetic metals according to the usual electromagnetic theory of dispersion. It yields a value for the proper periods and diameters of the elementary magnets and of the "magnetic conductivity." The wave-length of the proper oscillation, derived from the change of absorption of parallel wires with change of electromagnetic wave-length, is 5·9 cm. in the case of Fe, and 7·3 cm. in the case of Ni. The corresponding proper periods are $1{\cdot}97 \times 10^{-10}$ and $2{\cdot}43 \times 10^{-10}$ sec. respectively. The radii of the elementary magnets are $9{\cdot}4 \times 10^{-9}$ cm. for iron and $8{\cdot}3 \times 10^{-9}$ cm. for Ni (neglecting the crystalline structure of the metals). The viscosity appears to be about $1{\cdot}4 \times 10^{-5}$, which is of the same order as that of gases, thus recalling the applicability of the theory of Langevin's gases to ferromagnetic bodies, as shown by Weiss. E. E. F.

559. *Magnetic Properties of the Alkaline Metals in Combination.* **P. Pascal.** (Comptes Rendus, 158. pp. 37–39, Jan. 5, 1914.)—The additivity of diamagnetic properties, which has been established for organic compounds, can only be generalised in mineral chemistry in certain series of metals, the group of the alkaline metals being the most outstanding in this respect. The case of the elementary bodies is doubtful, since it is difficult to obtain the metals in a pure state free from iron. Their salts can, however, be obtained in the pure state, and these bodies exhibit strongly diamagnetic behaviour. The coefficient of molecular magnetisation was determined for seven different salts of the alkaline metals, and, that of the acid radical being known, the coefficient of atomic magnetisation was found by subtraction. The mean coefficients thus obtained were Li, 4·2; Na, 9·2; K, 18·5; Rb, 27·2; Cs, 41·0 (all multiplied by -10^{-6}). G. E. A.

560. *Magnetic Susceptibility of Paramagnetic Salts in Solution.* **A. Heydweiller.** (Deutsch. Phys. Gesell., Verh. 15. 21. pp. 1120–1122, Nov. 15, 1913.)—Measurements of the magnetic susceptibility of ferric chloride, manganous sulphate and nitrate, nickel nitrate, chromic sulphate

and nitrate, and cobalt nitrate in aqueous solutions show that the molecular susceptibility possesses a max. value at a certain concentration dependent on the nature of the dissolved salt. Further, ferric chloride and manganous sulphate and nitrate exhibit also minimal values at lower concentrations. Like most other properties, the magnetic susceptibility is presumably dependent on the degree of dissociation and increases with this. Starting with the greatest dilutions, increasing concentration is accompanied by diminution of the susceptibility, and this change the author regards as opposed by the formation of magnetic chains analogous to those of Grotthus, by means of which the susceptibility is increased. The subsequent diminution in the susceptibility is attributed to the formation of complexes, that is, of astatic ring systems. T. H. P.

561. *Magneto-chemistry of Iron Compounds and the Magneton Theory.* **B. Cabrera and E. Moles.** (Archives des Sciences, 86. pp. 502–518, Nov., 1918.)—Using an improved apparatus, the authors have continued their earlier investigations [see Abstract No. 1519 (1918)]. With aqueous ferric sulphate solutions, the number of magnetons tends to approach the value 27 as the concentration of the salt increases. When the hydrolysis of the salt is diminished by the addition of gradually increasing proportions of sulphuric acid the number of magnetons approaches more and more nearly to 29. This result agrees with the observation that the hydrogen ion restores the molecule to its original condition, the number of magnetons then approaching 29 (*loc. cit.*). The molecular susceptibility of potassium ferrocyanide is practically independent of its concentration. After being heated for 15 minutes at 80°, M/10-, M/20-, and M/40-solutions of ferric chloride exhibit diminished susceptibilities, the extent of the diminution, like the hydrolysis, being the greatest for the most dilute solution. T. H. P.

562. *Coefficient of Magnetisation of Nitric Oxide and the Magneton.* **P. Weiss and A. Piccard.** (Comptes Rendus, 157. pp. 916–918, Nov. 17, 1918.)—By means of a modification of the method previously employed [see Abstract No. 518 (1918)], the authors have measured the molecular coefficient of magnetisation of nitric oxide at 20°, the value found being $\chi_m = 1400{\cdot}8 \times 10^{-6}$. The number of magnetons per molecule is calculated to be 9·089, which differs from the integer by less than the experimental error of the measurements. T. H. P.

563. *Determination of Horizontal Intensity of Earth's Magnetic Field.* **W. A. Jenkins.** (Phil. Mag. 26. pp. 752–774, Oct., 1918.)—A new method is proposed for determining the horizontal intensity of the earth's magnetic field, the principle being to produce a known field opposite in direction to that of the earth and twice its value. The equality of the two fields, that due to the earth alone and that due to the combination, is determined by the equality of the times of vibration of the same magnet when the applied field is off and on, and the strength of the applied field is then determined by measuring the current producing it. Many of the corrections necessary to the ordinary magnetometer method may be eliminated, and the procedure thereby considerably shortened and simplified. Details are given of the construction of the helix, and magnet, with results of observations made at Sheffield. These confirm the claim that the new method gives values reliable to the fourth figure. C. P. B.

RADIOLOGY AND ELECTROPHYSIOLOGY.

564. *Powerful Röntgen-ray Tube with a Pure Electron Discharge.* **W. D. Coolidge.** (Phys. Rev. 2. Ser. 2. pp. 409–430, Dec., 1913. Electrical World, 63. pp. 220–221, Jan. 24, 1914. Abstract. Gen. Elect. Rev. 17. pp. 104–111, Feb., 1914.)—A new and powerful Röntgen-ray tube is described in detail. It differs in principle from the ordinary type in that the discharge current is purely thermionic in character. Both the tube and the electrodes are as thoroughly freed from gas as possible, and all the characteristics seem to indicate that positive ions play no appreciable rôle. The pressure, instead of being, as in the ordinary tube, a few microns (thousandths of a millimetre), is as low as it has been possible to make it, that is, not more than a few hundredths of a micron (*i.e.* a few hundred-thousandths of a mm.). The kathode consists of a body, which can be electrically heated (such as a tungsten or tantalum filament) and, suitably located with reference to this portion, an electrically conducting ring or cylinder, consisting preferably of molybdenum or tungsten or other refractory metal. The ring or cylinder is connected either to the heated portion of the kathode or to an external source of current, by means of which its potential may be brought to any desired value with respect to the heated portion. The heated portion of the kathode serves as the source of electrons, while the ring or cylinder assists in so shaping the electrical field in the neighbourhood of the kathode that the desired degree of focusing of the kathode-ray stream upon the target shall result. The antikathode, or target, functions at the same time as anode. The tube allows current to pass in only one direction and can therefore be operated from either direct or alternating current. The intensity and the penetrating power of the Röntgen rays produced are both under the complete control of the operator, and each can be instantly increased or decreased independently of the other. The tube can be operated continuously for hours, with either high- or low-discharge currents, without showing an appreciable change in either the intensity or the penetrating power of the resulting radiations. The tube in operation shows no fluorescence of the glass and no local heating of the anterior hemisphere. The starting and running voltage are the same. The tube permits of the realisation of intense homogeneous primary Röntgen rays of any desired penetrating power.

A. E. G.

565. *Cancer and Secondary Rays from Calcium Phosphate.* **R. A. Fessenden.** (Elect. Rev. and West. Electn. 63. p. 1267, Dec. 27, 1913.)—The author has accumulated a considerable amount of evidence to the effect that when cancer has been cured by radium, the effect has been due to secondary radiations from one of the constituents of bone material.

E. M.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

566. *Molecular Structure of Liquid Crystals.* **J. S. van der Lingen.** (Deutsch. Phys. Gesell., Verh. 15. 19. pp. 913–918, Oct. 15, 1913.)—When examined by the Röntgen-ray method of Laue, liquid-crystalline layers of *p*-azoxyanisol and *p*-azoxyphenetol do not give any indications of space-lattices. T. M. L.

567. *Intra-atomic Charge.* **A. van den Broek.** (Nature, 92. pp. 372–373, Nov. 27, 1913.)—According to Rutherford [Abstract No. 1847 (1911)] an atom consists of a very concentrated central nucleus of positive electricity surrounded by negative electrons distributed throughout the remainder of the atom. In the case of the scattering of α-particles by such a nucleus the ratio of the amount of scattering per atom divided by the square of the charge on the nucleus must be constant. Geiger and Marsden, however [Abstract No. 1296 (1913)], putting the nuclear charge proportional to the atomic weight, found values for the ratio, showing, not quite constancy, but systematic variation from 3·82 for Cu to 3·25 for Au. If now in these values the number M of the place in Mendelejeff's series (Cu = 29, Ag = 47, Sn = 50, Pt = 82, Au = 83) instead of A, the atomic weight be taken, a real constant is obtained. Hence the nuclear charge of an atom is not equal to half the atomic weight but to its place number in the periodic table. Should thus the mass of the atom consist for by far the greatest part of α-particles, then the nucleus too must contain electrons to compensate this extra charge. E. M.

568. *Intra-atomic Charge.* **F. Soddy.** (Nature, 92. pp. 399–400, Dec. 4, 1913.)—The author considers that recent generalisations as to the radio-elements and the periodic law [Abstract No. 170 (1914), etc.] support the conclusion of van den Broek [see preceding Abstract], that the intra-atomic charge of an atom is determined by its place in the periodic table rather than by its atomic weight. Thus the successive expulsion of one α- and two β-particles in three radio-active changes, in any order, brings the intra-atomic charge of the element back to its initial value, and the element back to its original place in the periodic table. On Rutherford's theory this is equivalent to assuming that the positive charge on the nucleus is the difference between a positive and a smaller negative charge.

If β-particles expelled in radio-active transformation do not come from the "nucleus" but from the same region of the atom as the electrons concerned in ordinary chemical changes, then the author deduces, as follows, that Ur in its tetravalent compounds ought to be non-separable from thorium compounds: UrX, formed from UrI by expulsion of an α-particle, is chemically identical with, and non-separable from, thorium compounds [Abstract No. 170 (1914)], as also is ionium formed in the same way from UrII. UrX loses two β-particles and passes back into UrII chemically identical with UrI. Uranous salts also lose two electrons and pass into the more common hexavalent uranyl compounds. Thus if these electrons come from the same region of the atom uranous salts should be chemically non-separable from thorium salts. Fleck has shown that this is not the case, and the author therefore considers this as a proof that β-particles come from the nucleus. E. M.

569. *Intra-atomic Charge and the Structure of the Atom.* **A. van den Broek.** (Nature, 92. pp. 476–478, Dec. 25, 1913.)—The paper discusses the nature of the nucleus of an atom and the question as to whether its algebraic positive charge is the atomic number or the place in Mendelejeff's table [see preceding Abstract and next Abstract]. A condensed periodic table is suggested and considerations are given of the connection between the atomic weight of an atom A, its place in Mendelejeff's table M, its place in the condensed table P, and the number of electrons in the nucleus, kP^2 ($k =$ a constant). It is shown that $A - 2M = kP^2$. It is also shown that Whiddington's relation for the velocity v of a kathode particle required to excite the characteristic radiation in an atom, holds better for $v_1 \propto M$ than for $v \propto A$.

It is possible that a cluster of α-particles may be at the centre of an atom with some rings of electrons of a diam. smaller than 3×10^{-12} cm. These rings may have no influence at all on the properties of the elements and for an electron penetrating from without will belong to the nucleus, while for an electron ejected from the innermost ring they will not. So the characteristic radiation will depend on M and not on A, since an electron penetrating the atom must pass through the region of M electrons, to excite, if it is of the right velocity, the outer rings of what, from a chemical point of view, might be called the nucleus. But a β-particle ejected from the innermost ring must pass all other rings and excite radiation different for each ring and for each "isotope." [See Soddy, Abstract No. 170 (1914).] E. M.

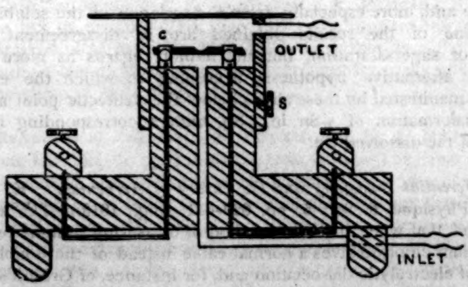
570. *Structure of the Atom.* **E. Rutherford.** (Nature, 92. p. 423, Dec. 11, 1913).—The paper contains a discussion of the nature of the charge on the "nucleus" of an atom [see Abstract No. 1347 (1911)] and the question as to whether β-particles originate from it or from the external electrons. The strongest evidence in support of the former view is (1) β-ray, like α-ray, transformations are independent of physical and chemical conditions; (2) the energy emitted in the form of β- and γ-rays by the transformation of an atom of RaC is much greater than could be expected to be stored up in the external electronic system. At the same time the author considers it probable that a considerable fraction of the β-rays which are expelled from radio-active substances arise from the external electrons. This, however, is probably a secondary effect resulting from the primary expulsion of a β-particle from the nucleus. It would appear that the algebraic positive charge on the nucleus is the fundamental constant which determines the physical and chemical properties of the atom, while the atomic weight, although it approximately follows the order of the nucleus charge, is probably a complicated function of the latter depending on the detailed structure of the nucleus. E. M.

571. *Decompositions by Ultra-violet Light* (*Organic Compounds, Metallic Iodides*). **A. Kailan.** (Akad. Wiss. Wien, Ber. 122. 2a. pp. 751–786, April, 1913.)—In the case of organic acids the author merely determines, by means of titration with alkali, the proportion of decomposed acid. Of these, acetic acid showed most, and oxalic acid least decomposition, and the introduction of the hydroxyl group increased the rate of decomposition. Quartz vessels were used; no decomposition was observed in glass vessels. The oxygen absorbed from the air did not seem to be concerned in these reactions, since evacuation of the acid solutions made no difference. The rotation of fermentation amyl alcohol was not affected by 3¼ hours of radiation, although some acid and some water were formed. The iodides of Ba and Sr were more rapidly

decomposed than those of the alkalies, but this held only for neutral, not for acid solutions; one addition of 1/800 mol. per litre of HCl increased the rate of decomposition, but further addition of acid had no effect. Intermittent radiations proved relatively more powerful than continuous radiation owing to the effect of atmospheric oxygen; with evacuation before subjection to the radiation the effects were diminished by one-half. The presence of thiosulphate, of acid, of primarily formed H_2O_2, as well as heating, hardly affected the rate of decomposition. Aqueous solution of potassium fluoride was not decomposed in 2 hours. Reference is made chiefly to Berthelot and Gaudechon and to W. H. Ross. H. B.

572. *Chemical Action of Penetrating Radium Rays.* VI. *Action on the Iodides of the Alkaline Earth Elements.* **A. Kailan.** (Akad. Wiss. Wien, Ber. 122. 2a. pp. 787–810, April, 1913.)—The experiments [see Abstracts Nos. 716 and 1741 (1913)] were made with neutral or acid (HCl) aqueous and alcoholic solutions of the iodides of Mg, Ca, Sr, Ba. The resulting decomposition was determined by means of thiosulphate. The iodides behaved on the whole like those of the alkalies; no relation between the rapidity of the decomposition and the atomic weight could be found, yet the Sr and also the Ba salts were more readily decomposed than the alkali salts; but the SrI_2 showed certain anomalies. The decomposition was more rapid in the case of the solutions in absolute alcohol of the MgI_2 than in the case of the aqueous solutions, neutral and acid. The action of the radium rays was of the same nature as that of ultra-violet rays; but the effect of from 80 to 200 mgm. of the radium rays (calculated for the metallic Ra) was only 1/200 to 1/800th of the effect of the ultra-violet rays of a quartz mercury lamp at 8 cm. distance, and the ratios of the orders of magnitude differed. H. B.

573. *Fractionation of Alloys and Minerals in the Electric Micro-furnace.* **A. L. Fletcher.** (Chem. Soc., Journ. 103. pp. 2097–2108, Dec., 1913.)—The micro-furnace, which is illustrated by the accompanying diagram, consists of a brass drum sliding over a solid slate cylinder 5 to 8 cm. in diam., carrying terminals for a carbon rod which can be rapidly heated electrically to extremely high temperatures. The cylinder is covered by a sheet of glass, fused silica or porcelain, and the enclosed space can be filled with various gases or partially exhausted. In application to qualitative analysis a small quantity of the material is placed in the depression, volatilised, and the deposit examined. Tables are given showing the colour of the deposits



obtained from a large number of metals in atmospheres of air, hydrogen sulphide, and iodine. Quantitative separations have also been made on a large number of alloys. The difficulties met with are (1) mechanical retention of the more volatile metal by the less volatile one, (2) the alloy (more particularly alloys of Al) does not assume the spherical condition, and (3) oxidation. In every case the residue and not the sublimate is weighed. As illustrative of the delicacy of detection of certain elements, it has been found that the zinc present in 0·0005 gm. of coinage bronze can readily be detected when distilled on to glass, the actual quantity being 5×10^{-6} gm. The method has also been applied to the rapid examination of such minerals as sylvanite and psilomelane. F. C. A. H. L.

574. *Chemical Action of Penetrating Radium Rays.* VII. *Action on Dextrose, Alcohol, Organic Acids and Silver Nitrate.* **A. Kailan.** (Akad. Wiss. Wien, Ber. 122. 2a. pp. 811–881, April, 1913.)—The rotation of 200 cm.³ of normal aqueous solution of dextrose was not visibly affected at 5° and 10° in 2850 hours by the radiations from 108 mgm. of $RaCl_2$; there was, however, some formation of acid, more than with sucrose, and more than would be accounted for by the action of any H_2O_2 formed. Absolute ethyl alcohol is oxidised to aldehyde and acid, and water is split off. Succinic and malonic acids are affected to a very slight degree, much less than by ultra-violet rays (similarly as with alkali iodides), and the electrolytic conductivity and dissociation seem to remain unchanged. The penetrating rays of 42 mgm. $RaCl_2$ acting for 4000 hours at from 8° to 8° C. in the dark on 5 gm. $AgNO_3$ in aqueous N/4 solution reduced about one-thousandth of the silver, which was deposited on the glass as a grey film ; the solution remained neutral.

H. B.

575. *Influence of Thermal Treatment on the Solidification and Transformation of Tin-Cadmium Alloys.* **D. Mazzotto.** (N. Cimento, 6. Ser. 6. pp. 194–211, Sept., 1913.)—Further studies have now been made on these alloys [see Abstract No. 172 (1914)]. With tin-cadmium alloys, although the effects of thermal treatment are small, yet they occur in the sense and intensity to be expected from the form assumed by the melting-point diagram below the eutectic line and, more especially, from the variation of the solubility of Cd in Sn. None of the results obtained are in disagreement with the hypothesis of supersaturation, but the author regards as more probably correct the alternative hypothesis, according to which the exothermal phenomena manifested by these alloys below their eutectic point are caused by the transformation of γ-Sn in β-Sn, with a corresponding immediate separation of the dissolved Cd. T. H. P.

576. *Differential Ionometry and the Theory of Arrhenius.* **E. Fouard.** (Journ. de Physique, 8. Ser. 5. pp. 629–641, Aug., 1913.)—The author has already found that when his own method of measuring osmotic pressures is used, potassium chloride gives a normal value instead of the double value of the theory of electrolytic dissociation and, for instance, of Griffith's measurements of freezing-points. He now shows that the lowering of the vapour pressure is substantially the same for normal solutions of potassium chloride and of cane-sugar, the *i*-factor being 1·67 for the former and 1·68 for the latter, and the "degree of dissociation" α being calculated as 67 % for KCl and 68 % for sugar. The origin of the anomaly is discussed, but without coming to any precise conclusion. T. M. L.

577. *Solubility of Radium Emanation and Other Gases in Liquids.* **S. Meyer** (Akad. Wiss. Wien, Ber. 122. 2a. pp. 1281–1294, July, 1913.)—The author shows that the solubility of RaEm and a series of other gases (H_2, N_2, CO, NO, O_2, Ar) in water can be expressed by the formula $\alpha = A + Be^{-\nu\theta}$, where A is the amount dissolved at the boiling-point, A + B the amount dissolved at the melting-point, and ν is a constant which characterises the liberation of gas with rising temperature. The same formula also holds for other liquids if θ be expressed in terms of the difference between the melting- and boiling-points. It is found that the constant ν is practically independent of the particular gas or solvent. E. M.

578. *Attempts to Separate Radium D from Lead.* **F. Paneth** and **G. v. Hevesy.** (Akad. Wiss. Wien, Ber. 122. 2a. pp. 993–1000, May, 1913.)—According to recent speculations on the chemical nature of the radio-elements [see Soddy, Abstract No. 170 (1914)] it is to be expected that RaD and lead should be chemically non-separable. In the present experiments exhaustive attempts were made to effect a separation, but with no success. In addition to numerous chemical precipitations, electrolysis of the solution and the fused salt was tried, also diffusion, dialysis, and distillation at 1000° C. E. M.

579. *Radio-elements as Indicators in Analytical Chemistry.* **F. Paneth** and **G. v. Hevesy.** (Akad. Wiss. Wien, Ber. 122. 2a. pp. 1001–1007, May, 1913.)—Since most of the radio-elements can be detected when present in extremely small amounts, the authors suggest their use as indicators in various operations. For instance, in investigating the solubility of lead chromate in water or of lead sulphide in saturated H_2S solution advantage can be taken of the fact that when RaD is once mixed with the salt, its concentration cannot be altered [see preceding Abstract]. Consequently, by determining the relative activities of the dissolved and undissolved lead salt, the solubility can be determined. The experiments give $1{\cdot}2 \times 10^{-5}$ gm. per litre at 25° C. for lead chromate in water, and $1{\cdot}5 \times 10^{-4}$ gm. per litre at 25° C. for lead sulphide in water saturated with H_2S. E. M.

580. *Colloidal Solutions of Radio-elements.* **F. Paneth.** (Akad. Wiss. Wien, Ber. 122. 2a. pp. 1079–1084, June, 1913.)—In continuation of the experiments described in Abstract No. 1748 (1913), the author finds that the nitrates of those radio-elements which dissociate hydrolytically, easily split up forming colloidal solutions of hydroxides. E. M.

581. *Extraction of Polonium.* **F. Paneth** and **G. v. Hevesy.** (Akad. Wiss. Wien, Ber. 122. 2a. pp. 1049–1052, June, 1913.)—The paper deals mainly with the separation of polonium from the radio-lead residues of pitchblende. By electrolysis of the solution, using a p.d. of only 0·08 volt the Po is concentrated on the kathode. However, the only method of completely separating Po once it has been deposited on Pt, is by distillation at 1000° C., preferably in a quartz tube with a feeble stream of CO_2 or H. When the Po is condensing it has different affinities for different surfaces. Thus if similar cold sheets of Pt and Au are exposed, nearly 40 times as much is deposited on the Pt as on the Au. Pd is still better than Pt. The authors consider, however, that the best method of obtaining Po from solution is by rotating a sheet of copper in it, 80 % of the Po being deposited. Another method of separation is by dialysis [see Abstract 1748 (1913)]. E. M.

582. *Electro-chemical Interchangeability of the Radio-active Elements.* **F. Paneth** and **G. v. Hevesy.** (Akad. Wiss. Wien, Ber. 122. 2a. pp. 1037–1047, June, 1913.)—Experiments are described showing that the disintegration points of ThC, and RaE are the same as that of Bi, those of RaD and ThB the same as that of Pb, that of RaA about that of Po. The separation of ThB is checked by the presence of Pb, and that of ThC or RaE by the presence of Bi. It is pointed out that this fact affords a means of considerably increasing the purity of radio-active elements separated by electrochemical means. The anodal separation of Po and other radio-active elements is satisfactorily explained on the view that the potential, and not the current, is the important factor that comes into play. The separation of ThB at extraordinarily high potentials is accounted for by the formation of ThB-superoxide which has the same disintegration point as PbO_2. E. A. O.

583. *Effect of Light on Decomposition Voltage.* **A. Leighton.** (Journ. Phys. Chem. 17. pp. 695–702, Nov. 1913.)—A mercury lamp was immersed midway between the electrodes in an electrolysis cell containing copper sulphate solution. By means of a rubber cloth it was possible to shield either electrode from the light or both electrodes if necessary, and the decomposition voltage could thus be read under varying conditions of illumination of the electrodes, which were either of graphite or platinum. It was found that the decomposition voltage between Pt electrodes is not affected appreciably when the anode alone is illuminated, but is decreased when the kathode is illuminated. It is possible to regulate the voltage so as to make copper deposit on the shaded portion of a Pt kathode and not on the illuminated portion. Graphite adsorbs a cuprous salt from a solution of copper sulphate, which acts as an anodic depolariser and can be removed by electrolytic oxidation; the reaction is accelerated by light. Owing to this adsorption the decomposition voltage for a copper sulphate solution with a graphite anode and a Pt kathode can be brought down temporarily to about 0·4 volt. T. S. P.

584. *Electrolytic Reduction of Iron for Analysis.* **J. C. Hostetter.** (Washington Acad. Sci., Journ. 3. No. 16, 1913. Chem. News, 108. pp. 239–240, Nov. 14, 1913.)—The author describes an electrolytic method for the reduction of ferric to ferrous salts in sulphuric acid solution, preliminary to the estimation of the iron by titration with permanganate. A gold dish kathode is used and a Pt anode, the latter being surrounded by a small porous pot. 0·5 gm. of iron in the ferric state is reduced in 60–120 mins., using 4·8 to 10 amps. at 4·5 to 10 volts. T. S. P.

585. *Rapid Refining of Copper with a Rotating Kathode.* **C. W. Bennett** and **C. O. Brown.** (Journ. Phys. Chem. 17. pp. 685–694, Nov., 1913.)—An apparatus is described by which the electrolytic refining of copper can be demonstrated to students. Currents as high as 65 amps. per $dm.^2$ at the kathode can be used, and 100 gm. of copper deposited in an hour. Experiments are described in which the usual impurities of copper are separated from artificially prepared anodes. Working scale drawings are given of the apparatus. The kathode makes about 5000 revs. per min. [See Abstracts Nos. 1294 (1912) and 1873 (1913).] T. S. P.